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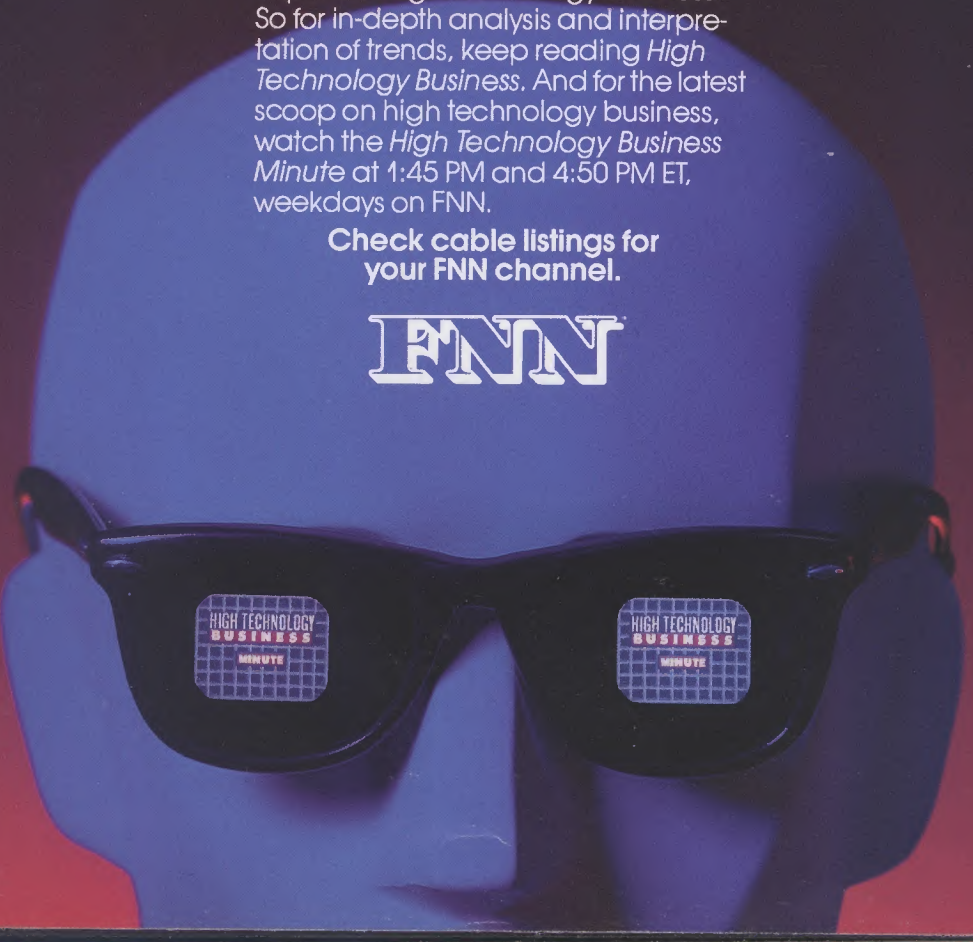

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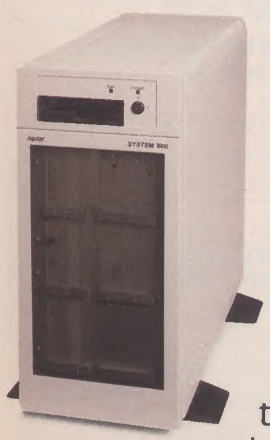

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United Telecom Inc.'s current stock price of $30 fails to reflect the continued turnaround of US Sprint. United Telecom owns half of Sprint, and the convalescence of the long-distance carrier should push its parent com-

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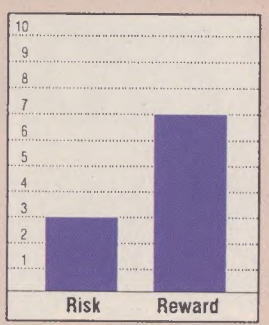

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3. Earnings Per Share:	
last quarter	$.29
last fiscal year	$.55
4. Estimated Earnings Per Share:	
next quarter	$.40
next fiscal year	$1.90
5. Recent Stock Price	$30
6. Target Price (6-12 Months)	$38

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RISC and Reward In the Market

BETTER TECHNOLOGY may, but may not, bring business success. Take the case of new microchips that employ reduced instruction-set computing, or RISC—a radically simplified microprocessor design that can boost computing speed several times. RISC sounds like a benefit from both the technology and user perspectives: new architecture, greater speed, ability to solve problems more quickly—all the ingredients for marketplace success.

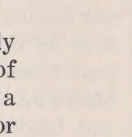
But it's not so simple. RISC's design makes it incompatible with existing software. Should computer makers adapt to RISC? Should software manufacturers offer programs both in RISC and conventional versions? And to make matters still more complicated, acceptance of RISC is closely tied to the growing, but still comparatively small, use of the Unix operating system. Unix can run on several kinds of processors, including RISC chips, while the older (but far more widely used) MS-DOS system runs only on Intel's non-RISC chips.

Will RISC's undoubted superiority in speed be enough to bring marketplace success to the technologically advanced new chips? Big bets are being placed on the answer to that question. You'll meet the bettors beginning on p. 18.

Technological developments often emerge more quickly than marketplace uses for new products, and a misreading of the market can be disastrous. Judge for yourself whether a recently discovered all-new superconductor application, or the ability to make desktop 3-D graphics programs jump through HOOPS, will be a commercial success or a technological curiosity. Those items appear in *Newsletter Digest*, starting on p. 43. Questions about the market for new technologies also underlie our update on the status of interleukin-2 (p. 33) and our look at the effect on the computer industry of the crumbling of intra-European trade barriers (p. 24).

Even when the market drives the technology, as in degradable plastics and the environmental legislation that is fueling their development (p. 30), marketplace success is not assured. Are political forces sufficiently stable and fast-growing to bring success to companies that respond to them?

Success is, after all, what *High Technology Business* is all about, so we thought it important to showcase technological successes. This month, as we continue to introduce features reflecting areas that concern our readers, you will find the first of our new monthly *Success Story* reports on p. 41. Correct handling of technology does bring business success; every month, we'll show you a company that has found the technological way to a better bottom line.



Artificial Intelligence

THE POINT RAISED in Alex Kozlov's article "Rethinking Artificial Intelligence" (May, p.18) is certainly valid—successful AI companies are those that are abandoning the "ivory tower" approach and listening to the market. However, in focusing on five "emerging champions," he neglected one company that has had the right approach all along. Software AE, founded in 1978, is the oldest profitable expert-system-shell company in the industry. Our KES shell, the first to be developed and delivered in C, is running on more hardware platforms than any other shell on the market today. In 1987, KES sales were double those of 1986, an accomplishment we expect to repeat in 1988. The success of KES has attracted Control Data, Unisys, and Prime Computer to sign agreements giving them the right to use and market it along with their own products.

There undoubtedly will be a continuing shakeout in the AI industry. When the dust settles, Software AE will still be there.

Joseph Fox, Chairman
Software AE Inc.
Arlington, Virginia

I COULD NOT agree more with your assessment of the artificial-intelligence industry; taking a market approach to selling AI products is definitely the wave of the future. Another trend is toward custom-building expert systems, because generic systems usually do not address a customer's specific needs, and can require extra effort and expense to implement.

The expert-system market is beginning to segment into categories such as manufacturing, legal, financial, and diagnostic, and all these markets are spawning AI companies. Our company focuses on diagnostic products for electro-mechanical devices, and we construct our products using the block diagrams and schematics of the devices to be tested.

Kevin Flood, Business Operations
AI Squared Inc.
North Chelmsford, Massachusetts

IN YOUR MAY cover story, "Rethinking Artificial Intelligence," New Science Associates is described as an AI company located in Stamford, Connecticut (in the box on page 22). We would be more correctly identified as a market research and consulting firm, and we are located in South Norwalk. In fact, as our revenues should reach $2 million this year, largely derived from artificial-intelligence research, I am quite sure that we are the largest AI research firm in the world.

In addition, the survey we conducted, which is cited in the box, focused only on expert systems, not on artificial intelligence in general.

Kenneth R. Sonenclar, President
New Science Associates Inc.
South Norwalk, Connecticut

Expert Analysis

WHAT A GOOD analysis you've done of our industry in your May article "Business TV Becomes Big Business." In the past three or four years, there have been a lot of articles written in the trade and business press on this industry. Most are poorly researched and usually confuse business television with two-way videoconferencing, a much different application and technology. Thank you for the service to this industry and to the business community in general.

David Green, Vice President
VideoStar Connections Inc.
Atlanta, Georgia

A Grave-Spinner

RE: "PICKING UP the Pieces of RCA" (May, p. 41): Record Company of America? David Sarnoff, who founded the Radio Corporation of America, is turning over in his grave.

Ren Rastorfer
New York, New York

Those Who Wait Fall Behind

AS AN AEROSPACE engineer who has worked on space-based weapon systems, I am alarmed at the erosion of our space-deployment capability. The Soviets have a *ten-year* lead on us in solid-rocket-fuel technology. Their largest booster has a 100-ton launch capability; our largest booster, a mere 10 tons. Current plans to upgrade U.S. boosters will result in the ability to launch 30 tons into earth orbit by 1995—insignificant compared to Soviet efforts.

The Soviets also have a substantial lead in the number of successful launches, launching about 200 payloads per year. Their systems are extremely redundant and quite reliable. Their craft are equipped with the latest in computer systems, just as good, if not better, than ours. The Soviets also have the longest duration flights of both manned and unmanned spacecraft.

This year the Soviets will launch their version of the space shuttle. They have two designs in production; we have only one. Also, the Soviets operate out of two enormous space complexes; we have one.

The United States has excellent developmental programs ready to go—the space station, the space plane, and the space telescope. NASA would like to start to explore Mars and the moon. The Air Force has developed an engine that can achieve speeds up to 25 percent that of light; this would allow flight to nearby stars. But NASA's budget of about $9 billion is wholly insufficient. Congress is attempting to reduce the scope of the space station. NASA has been resisting these changes, opting to delay construction. Space exploitation is impossible without a manned space station. Like nations in the 1600s, those who wait fall behind.

Robert S. VannRox
Columbia City, Indiana

In our May article "New Methods Deliver Medicine and Profits," the table describing makers of drug-delivery systems incorrectly listed Enzytech of Cambridge, Mass., as "Enzotech." Enzytech's research involves stabilizing protein medicines so they can be delivered over longer periods of time, and methods of administering polypeptides by mouth.

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

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New Developments

Issues, products and advances that help create new opportunities for high-tech businesses

Computers Break Speed Limit

A BREAKTHROUGH in parallel computing means that a class of high-speed computers may finally fulfill its potential.

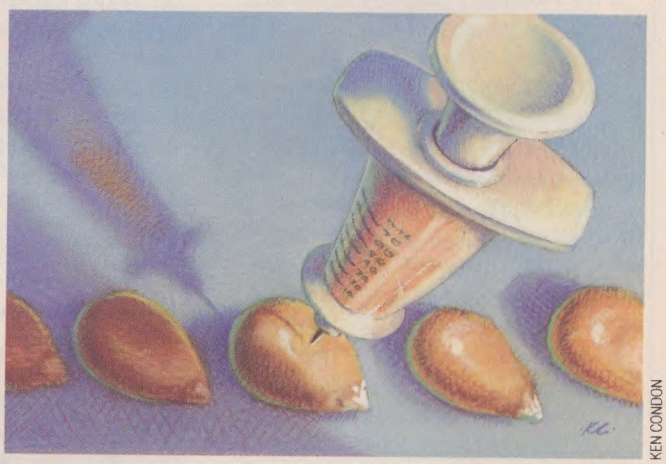
Parallel-processing computers, better known as parallel processors, incorporate hundreds or thousands of number-crunching processor chips. These chips divide up a complex problem and work on many parts of it at once, in a "parallel" fashion. Traditional "serial" computers send the entire problem through one chip, slowing down the job.

Every computing task, from designing an airplane wing to estimating the yield of a stock portfolio, has both parallel and serial elements, each best handled by the associated type of computer. Computer programmers long ago figured out how to nearly eliminate the parallel part of many problems, but couldn't reduce the serial portion. As a result, parallel machines could run no more than 100 times faster than serial computers—not fast enough to justify rewriting serial software to work on parallel computers.

Last year, researchers at Sandia National Laboratories in Albuquerque, N.M., discovered how to bypass the bottleneck caused by a problem's serial elements. Dr. John L. Gustafson and his colleagues managed to make their parallel processor, a 1,024-chip Ncube Model 10, work 1,000 times faster than any single-processor computer. "Instead of shrinking the serial portion, we made the problem bigger," increasing its percentage of parallelism, explains Edwin Barsis, the lab's director of computer sciences.

Gustafson says there's no magic in the Sandia solution; re-sizing scientific and engineering computing problems is a common technique. However, parallel computers have been used primarily to perform modeling and simulations. The new approach may mean that programmers will soon begin to rewrite software to let parallel computers tackle a wider variety of tasks.

Gustafson predicts that the Sandia breakthrough will equip parallel computers for almost any computing job now handled by serial supercomputers. At Sandia, parallel computers already "are easily beating supercomputers," he says.



KEN CONDON

Vaccinations For Corn Seeds

FARMERS MAY soon be able to use a genetically engineered "vaccine" instead of pesticides to protect their corn. InCide, made by Crop Genetics International of Hanover, Md., wards off the European corn borer, a caterpillar-like bug that kills corn plants. The company hopes to gain Environmental Protection Agency approval by 1990.

To create InCide, Crop Genetics inserts a bacterium gene—whose protein is toxic to the corn borer and other creatures that don't have an alkaline stomach—into an endophyte, a microorganism that lives only inside plants.

When an inoculated corn seed grows, the endophyte reproduces inside the stalk and continuously wards off the borer without affecting the plant. Crop Genetics says it has no evidence that InCide will cause pesticide-linked problems such as cancer, bird deaths, and crop contamination.

Crop Genetics is growing test plots of InCide-treated corn in Maryland, and the vaccine is also being tested in France. The company hopes its $20-million investment in inoculated seed will claim more than a third of the $250-million corn-borer extermination market and reduce the borer's annual $400-million threat to U.S. farmers.

Crop Genetics says InCide can also protect soybean plants from certain pests, and the company is working on other bioinsecticides for rice and cotton plants.

Out, Out, Damned Spot

LADY MACBETH could have used the Stat Scrub, an automatic hand-washing machine. Dirty hands are the number-one carrier of disease-causing bacteria, and Pacific Biosystems Inc. of Phoenix, Ariz., makes three systems designed to clean bacteria off hands quickly and efficiently in operating rooms, day-care centers, doctors' offices, and restaurants.

The company says that its machines kill 65 percent more bacteria than does normal scrubbing with soap and water. Depending on the model, the self-cleaning machines cleanse hands and arms in 20 to 90 seconds, using high-powered sprays of anti-bacterial chemicals, air, and water.

A see-through top lets users see their hands being washed. This helps promote use of the machines when washing is not closely monitored, says company president Francis Keery. The Insta-Clens, made for the food industry, costs $1,750 and offers an optional $500 memory module that records employee use. The Medi-Clens, for general health-care facilities, costs $2,950, and the high-end Stat Scrub, designed for operating rooms, costs $19,500.

PACIFIC BIOSYSTEMS INC.

This clean machine bans bacteria from operating rooms and restaurants.

Bar Codes Break Out

ADVANCED versions of the bar-code scanners that speed supermarket checkout will soon show up in a variety of retail stores. By 1989, more than a quarter of all convenience stores will scan items, according to a survey done by Automatic Identification Manufacturers (AIM), an industry group. AIM predicts swift adoption of scanners by mass merchandisers as well. By 1990, for example, K Mart will have scanners in all 2,100 of its U.S. stores; only about a third now use the devices.

The textile and clothing industries also are betting on bar codes. With manufacturers and retailers sharing information acquired by scanners, suppliers could quickly adjust production to match emerging sales trends.

AUTOMATIC IDENTIFICATION MANUFACTURERS INC.

Bar-code scanners invade the mall.

Such widespread use will bolster the market for hand-held bar-code readers. Unlike the floor units used in supermarkets, most other retailers will buy smaller scanners from companies such as Computer Identics of Canton, Mass.; Symbol Technologies of Bohemia, N.Y.; Welch Allyn of Skaneateles Falls, N.Y.; and Intermec of Lynnwood, Wash. AIM predicts that sales of bar-code scanning equipment will increase by 30 percent a year for the next several years.

The recent development of tiny semiconductor lasers that emit beams of visible light will make hand-held scanners easier to use. Until recently, the only semiconductor lasers available produced infrared light, which reflects poorly from many product packages and may require several passes to read the code. Until Toshiba and NEC announced visible-light semiconductor lasers this year, the only source of visible-light lasers had been relatively dim light-emitting diodes, or large and expensive gas-tube lasers.

Freshness Test For Cooking Oil

THE U.S. food industry may soon have a way to ensure the freshness of cooking oil. Libra Laboratories Inc. of Piscataway, N.J., has been exporting its chemical-reaction test to Europe and now plans to sell it in the United States.

Overcooked oil can make food taste bad and cause indigestion. Some European countries require restaurants to pass oil-freshness tests, but restaurants and suppliers in this country have been on their own. Libra says its $1.50 test, performed in a test tube, checks oil in just 10 minutes; European tests can cost as much as $100 and take at least 90 minutes. The company says it has sold more than 500,000 kits for the patented test around the world.

Libra is seeking investment partners and has talked with several U.S. corporations about using the test to inspect oil in food or in large barrels after storage and transport.

CBIT CORP.

Digital quality-control works faster.

Inspection In 3-D

AN AUTOMATED three-dimensional inspection system from CBIT Corp. combines technologies to improve quality control for the food, pharmaceutical, and electronics industries.

CBIT, based in Malvern, Pa., says its CBI 1101 identifies product irregularities five times faster than do conventional systems. The system uses proprietary electronics linked to a new camera and lighting technique; it cuts analysis time by getting digital data directly from the camera. Standard video inspection systems use analog signals that must be converted to digital form before being analyzed.

The inspection machine can also "learn" to calculate the average dimensions of an acceptable product, so manufacturers do not have to enter inspection parameters manually.

The CBI 1101 costs about $20,000, which CBIT says is half the price of standard video-inspection systems.

More Ammunition to Fight Gum Disease

ROUGHLY TWO out of three Americans will develop some form of gum disease in their lifetime, and a computerized probe will help dentists identify such periodontal problems.

The probe, designed by John Hershfeld at Florida Probe Co. in Gainesville, electronically measures the depth of a gum pocket to detect loss of connective tissue, a prime indicator of gum disease. Hershfeld says his device measures pocket depth with an accuracy of one-tenth of a millimeter—10 times more accurately than manual probing.

The system works with a personal computer and costs about $2,800 for the probe, software, and computer hookup. Dentists can use the system to check the progress of gum-disease treatment on subsequent visits. As the dentist probes, arrows appear on the computer screen—red for worse, green for better, and yellow for no change. The customer gets a printout showing plaque accumulations, the precursor to periodontal disease, that can be removed with better flossing and brushing.

FLORIDA PROBE

Better diagnoses could help the millions of periodontal disease sufferers.

The best solution to the plaque problem, however, may be to avoid it entirely. Synergen of Boulder, Colo., is developing enzymes that bind to teeth for several hours to prevent the formation of plaque. These enzymes could be put into toothpaste, mouthwash, or chewing gum. Synergen president Larry Soll says a product could be on the market by the early 1990s.

The periodontal diagnostic and treatment market—including dental visits—will grow from about $5 billion today to about $15 billion by 1992, says George Stasen, a health-care analyst with Bradley & Company.

Group Pushes Code For Buildings

MANAGERS OF commercial buildings spend billions of dollars each year on computerized energy-management and security systems. Currently, these building-control products can communicate electronically only with equipment from the same maker, locking building managers into buying all their equipment from one supplier. This ensures the market dominance of a few large companies such as Honeywell and Johnson Controls.

To help open up the market, the Intelligent Buildings Institute (IBI), a Washington-based nonprofit trade group, is pushing manufacturers to adopt an "open protocol" that would let different makes of equipment exchange information. Such a standard would let a manufacturer of, say, temperature sensors, sell its products for a building equipped with another company's heaters. The new protocol will be modeled after standards now used for computer communication in offices and factories.

However, success would require close communication between competitors who jealously guard information about their products, acknowledges institute chairman Ronald J. Caffrey, who is also vice president of marketing at Johnson Controls.

Keyboard 'Plays' Chinese

A COMPUTER keyboard from Sino Business Machines (SBM) may help China compete in the information-processing arena. Chinese typists typically spend months learning the 2,000-key, five-shift keyboard needed to accommodate Chinese characters. But SBM's keyboard types in Chinese with just 81 keys, and the company claims that anyone who writes Chinese can learn to use it in two weeks. The product works three to four times faster than current Chinese keyboards.

The SBM system works like a piano keyboard. Just as a pianist plays several notes at once to sound a chord, a typist strikes several keys simultaneously to create a character.

SBM, based in San Diego, introduced the first proto-

type of the keyboard early this year, and Byte Business Systems of La Jolla, Calif., plans to introduce typewriters, word processors, and computer terminals using it this year. SBM will market its technology through original equipment manufacturers; the company hopes to have personal computers, typesetting systems, and a teletypewriter on the market in 12 to 18 months.

SBM says office equipment using its new keyboard will cost about as much as equivalent machines using American-style keyboards, and compete against word-processing software that converts standard keystrokes into Chinese characters. After mastering Chinese, SBM hopes to create keyboards for other languages.

Carmakers Race to Two-Stroke Engines

TWO-STROKE engines will probably spark the next international battle in the auto industry. Major car makers are racing to develop the technology, and the first versions should reach the market next year.

Conventional car engines use a four-stroke design. In each cylinder, the piston travels up and down twice (completing four strokes) between each firing of the spark plug. In the more efficient two-stroke design, the piston moves up and down only once between firings. Today's two-stroke engines are smaller and run more smoothly than four-stroke units of comparable power.

ORBITAL WALBRO CORP.

Two-stroke engines cut costs.

Small two-stroke engines have been used for years to power machines from chain saws to outboard motors. Recent breakthroughs in fuel injection, spearheaded by Australia's Orbital Engines, have created two-stroke models that run cleanly enough for use in cars.

Two-stroke engines use less fuel, and their light weight will help make front-wheel-drive cars better balanced and easier to steer. A two-stroke engine could cut the retail cost of a car by as much as $600 compared to a model run by an equivalent four-stroke unit, according to Orbital Engines.

"The Japanese are in a monumental scramble to be first," says Robert Brooks, former U.S. representative of the German engine developer Wankel GmbH and head of the consulting firm Technology Commercialization. According to published reports, an Asian company will begin building two-strokes using Orbital's injection technology by 1989.

In the United States, both Ford and General Motors have options on Orbital's design. Detroit insiders expect Ford and Chrysler to begin making two-stroke engines by 1990.

ALSO WORTH NOTING

■ The first condom for women is now being tested in the United States. Wisconsin Pharmacal Co., which manufactures the device in this country, expects to have it on the market by the end of the year. Made of durable polyurethane instead of the traditional latex, the loose-fitting, disposable sheath conforms to the walls of the vagina. The condom does not need professional fitting and could reduce the chance of contracting sexually transmitted diseases, including AIDS. In European trials, many couples found the female condom easier to use and more comfortable than other barrier contraceptives. Last year, more than $400-million worth of condoms were sold in the United States.

■ A battery that will work after lying dormant for as long as 20 years has been created by scientists at Sandia National Laboratories in Albuquerque, N.M. The device contains two alloys; when melted by a shock wave, these alloys combine to conduct electricity. The battery, which provides 3 amps of power at 2.5 volts for 10 minutes, will eventually see use in nuclear weapons and supply power in emergency situations. Sandia plans to license the technology after it obtains a patent.

WISCONSIN PHARMACAL

The female condom will help fight sexually transmitted diseases.

■ Westinghouse Electric Corp. has designed a less-expensive printing technology for high-quality laser printers. The system uses photolithography and etching techniques to define pixels on a thin layer of light-emitting film. Electrical charges activate the pixels, which in turn activate photosensitive material such as a photocopier drum. The company says its system will cost about $150, compared to $200 or $250 for conventional systems that offer limited resolution and require a bulky external light source. Westinghouse hopes to have a commercial version on the market by 1991.

■ Graffiti artists, beware. Decorarc Ltd. of Newcastle, England, is seeking U.S. licensees for its anti-graffiti products, which it claims are biodegradable, noncarcinogenic, noncaustic, and easy to apply. LRC Clearcoat, a urethane-based coating for concrete, stone, and marble, protects surfaces for as long as five years. Another product, called LRC Odeurow, removes graffiti from coated indoor surfaces; LRC Powerpack cleans outdoor areas. The products are already available in Europe.

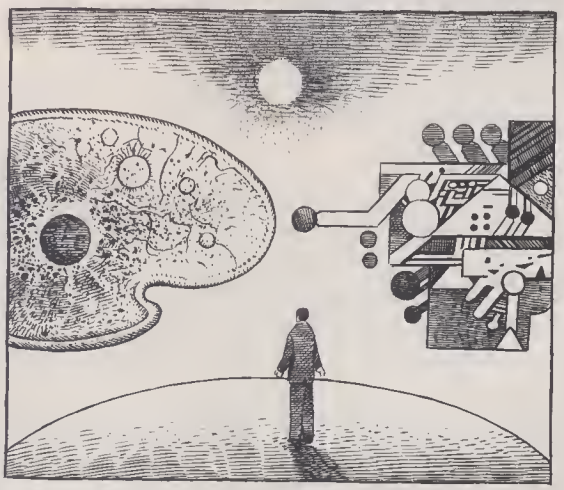
On the Biological Frontier

JAPANESE COMPANIES EXPLORE LIVING COMPUTERS

■ **By Robert Chapman Wood**

THE JAPANESE BELIEVE that the control of biotechnology represents the new "human frontier," and they intend to lead the world in exploring this unknown territory. As Americans fret over the consequences of biotechnology, the Japanese government has committed itself to controlling the mechanisms of life. Promoting a biological revolution in business over the next two decades has become a top national priority in Japan.

This commitment is most evident in the Human Frontier Project, Japan's most ambitious new science program. Officials at Japan's Ministry of International Trade and Industry (MITI) hope this project will result in innovations ranging from computers built from living cells to the production of polyethylene plastic by photosynthesis. Such goals are not unrealistic, says David Kingsbury, assistant director for biological, behavioral, and social sciences at the U.S. National Science Foundation. Kingsbury notes that U.S. research seeks similar goals. "We just don't talk about it as much," he says.



JAMES ENDICOTT

The Human Frontier Project represents a departure for Japan. Typically, the Japanese government organizes narrowly targeted government/industry projects to advance recently developed technologies that are not quite ready for aggressive commercialization. Biotechnology ventures that are now underway include studies of protein engineering, the molecular breeding of microorganisms, and new ways of producing ethanol (a type of alcohol useful as fuel) by such methods as fermenting cellulose.

In contrast, the Human Frontier Project aims to pursue fundamental research in cooperation with foreign governments. Japan is seeking co-sponsors and funding, but so far, no countries have signed up. Many foreigners, especially Europeans, see the program as "a smokescreen for a Japanese attempt to take over the pharmaceutical industry," says Kingsbury. When the project was first discussed in 1986, he says, "MITI guys were telling foreign scientists it was an opportunity to infuse their basic science into Japan, and that the Japanese would help develop it. It would be a small international grant program combing the world for new, exploitable technology. The European scientists sort of thought it was a good idea, but the European governments were appalled."

The Japanese may be genuine in their desire to cooperate with foreign scientists, but the tight relations between Japanese scientists and businesspeople mean that international research results will probably appear more rapidly in Japanese products than in those of the West.

The Human Frontier Project has two key goals. First is the understanding of brain functions, which could lead to artificial brains made from living cells. Japanese computer makers such as Fujitsu and NEC take this effort very seriously. Fujitsu, for instance, is exploring "bioelements" in its laboratories and hopes to apply them to its work on "neurocomputers," or computers that emulate the human brain. The second goal involves understanding biological functions at the molecular level, through such techniques as gene splicing. The project might also examine how nerves interact, with hopes of letting man-made devices communicate directly with the body.

Japan's deep commitment to biotechnology has gone beyond chemical and pharmaceutical houses such as Takeda Chemical and Green Cross Inc. into a variety of companies whose business involves an understanding of biology. These mainline companies, which include soy-sauce maker Kikkoman, Kirin Brewery, and seasonings producer Ajinomoto, possess some of the world's richest knowledge of microorganisms. Kirin Brewery, for example, is involved in eight government-sponsored biotechnology projects.

Even though U.S. pharmaceutical and chemical producers such as Eli Lilly and Eastman Kodak also show deep interest in the biotech revolution, the United States lacks an organized way to involve traditional food and alcohol producers.

Perhaps due to unease about the social implications of biotechnology, Americans are not focusing on the long-term opportunities the way we concentrate on developments in other fields. The fear of biotechnology is well founded. But if there's anything scarier than Frankenstein's monsters emerging from the labs of U.S. scientists, it would be Frankenstein's monsters mass-produced in Japan. ■

Robert Chapman Wood is an analyst and business consultant who specializes in technology and the Japanese economy.

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ANDREW SEYBOLD'S OUTLOOK ON PROFESSIONAL COMPUTING

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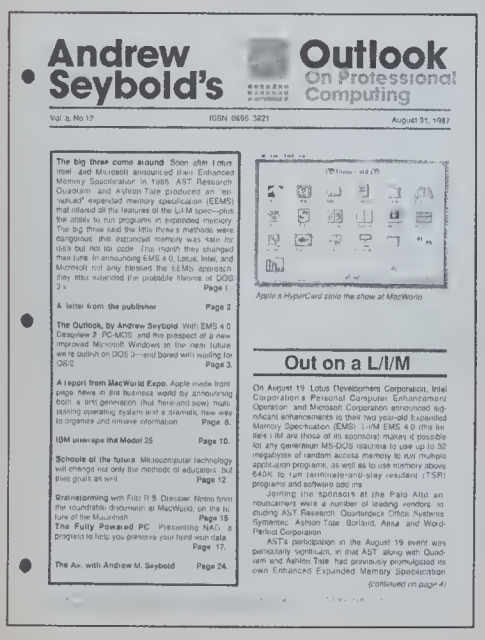

Andrew Seybold's Outlook On Professional Computing

Vol. 5, No. 17 ISBN 0895-3821 August 31, 1987

The big three come around Soon after Lotus Intel and Microsoft announced their Enhanced Memory Specification in 1985 AST Research Quadram and Ashton Tate produced an "enhanced" expanded memory specification (EEMS) that offered all the features of the LIM spec—plus the ability to run programs in expanded memory. The big three said the little three's methods were dangerous that expanded memory was safe for data but not for code. This month they changed their tune. In announcing EMS 4.0, Lotus, Intel, and Microsoft not only blessed the EEMS approach they also extended the probable lifetime of DOS 3.x Page 1

A letter from the publisher Page 2

The Outlook, by Andrew Seybold With EMS 4.0 Desqview 2 PC-MOS and the prospect of a new improved Microsoft Windows in the near future we're bullish on DOS 3—and bored with waiting for OS/2 Page 3.

A report from MacWorld Expo Apple made front page news in the business world by announcing both a first generation (but here-and-now) multitasking operating system and a dramatic, new way to organize and retrieve information Page 6.

IBM unwraps the Model 25 Page 10.

Schools of the future Microcomputer technology will change not only the methods of education but their goals as well Page 12

Brainstorming with Fritz R.S. Dresler Notes from the roundtable discussion at MacWorld, on the future of the Macintosh Page 15

The Fully Powered PC Presenting NAO, a program to help you preserve your hard-won data Page 17.

The A>, with Andrew M. Seybold Page 24.

Apple's HyperCard stole the show at MacWorld

Out on a L/I/M

On August 19 Lotus Development Corporation, Intel Corporation's Personal Computer Enhancement Operation and Metaset Corporation announced significant enhancements to their two year-old Expanded Memory Specification (EMS). LIM EMS 4.0 (the latest LIM are those of its sponsors) makes it possible for any generation MS-DOS machine to use up to 32 megabytes of random access memory to run multiple application programs, as well as to use memory above 640K to run terminate-and-stay-resident (TSR) programs and software add ins.

Joining the sponsors at the Palo Alto announcement were a number of leading vendors including AST Research Quarterdeck Office Systems Symantec Ashton-Tate Borland, Ansa and Word-Perfect Corporation

AST's participation in the August 19 event was particularly significant, in that AST along with Quadram and Ashton-Tate had previously promulgated its own Enhanced Expanded Memory Specification

(continued on page 4)

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The High-Tech Bookshelf

VIEWS ON VALUATIONS, GROWTH, SUPPORT, MANAGEMENT

■ **By Mark J. Estren**

Business Valuation Manual
by Thomas Horn.
Charter Oak Press. 224 pages. $29.95.

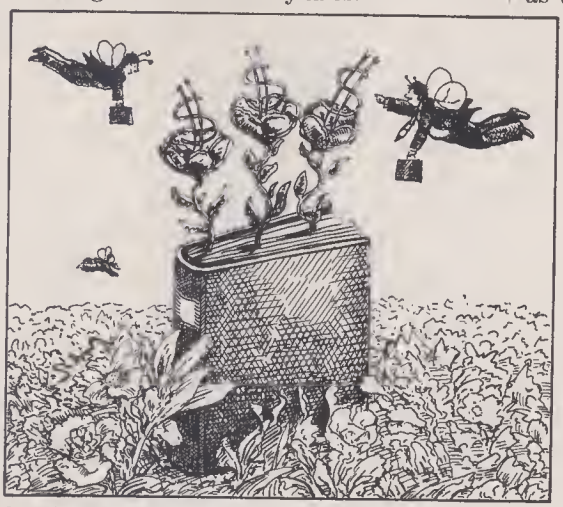
There's heavy going here for general business readers, but in a worthy cause: learning how businesses are valued and what companies are worth.

Venture-capital professionals routinely make proposals that business founders and managers consider outrageously low. Owners will get a fairer price if they understand how the financial pros come up with their numbers. That means wading through the problem of market value vs. liquidation value, discounted cash flow, capitalization of income stream, and so on—not to mention Internal Revenue Service rules affecting all of the above.

Why bother? Because entrepreneurs won't know if they are being offered a great opportunity or taken to the cleaners unless they take the time to understand how professionals determine the value of a business. No book makes this complex, tricky subject easy, but Horn, a merger and acquisition specialist from Lancaster, Pa., is a good guide through the murky waters, providing a straightforward volume with a useful glossary.

Growing a Business
by Paul Hawken.
Simon & Schuster. 252 pages. $16.95.

Although billed as a companion volume to a public television series that aired late last year, this book stands nicely on its own as a well-written, often entertainingly counter-intuitive look at ways to start, manage, and grow small companies, including—of course—high-technology firms. Hawken's own California-based garden-and-horticultural-catalog company may be decidedly low-tech, but his comments apply to high-tech organizations as well: "The most perilous period in a company's development [comes] when it starts to succeed wildly, enjoys high earnings, and shows rapid sales growth. These three elements can breed mistakes that are masked by outward prosperity." Hawken offers a good blend of upbeat tips—with fewer cliches than the average—and cautionary tales.



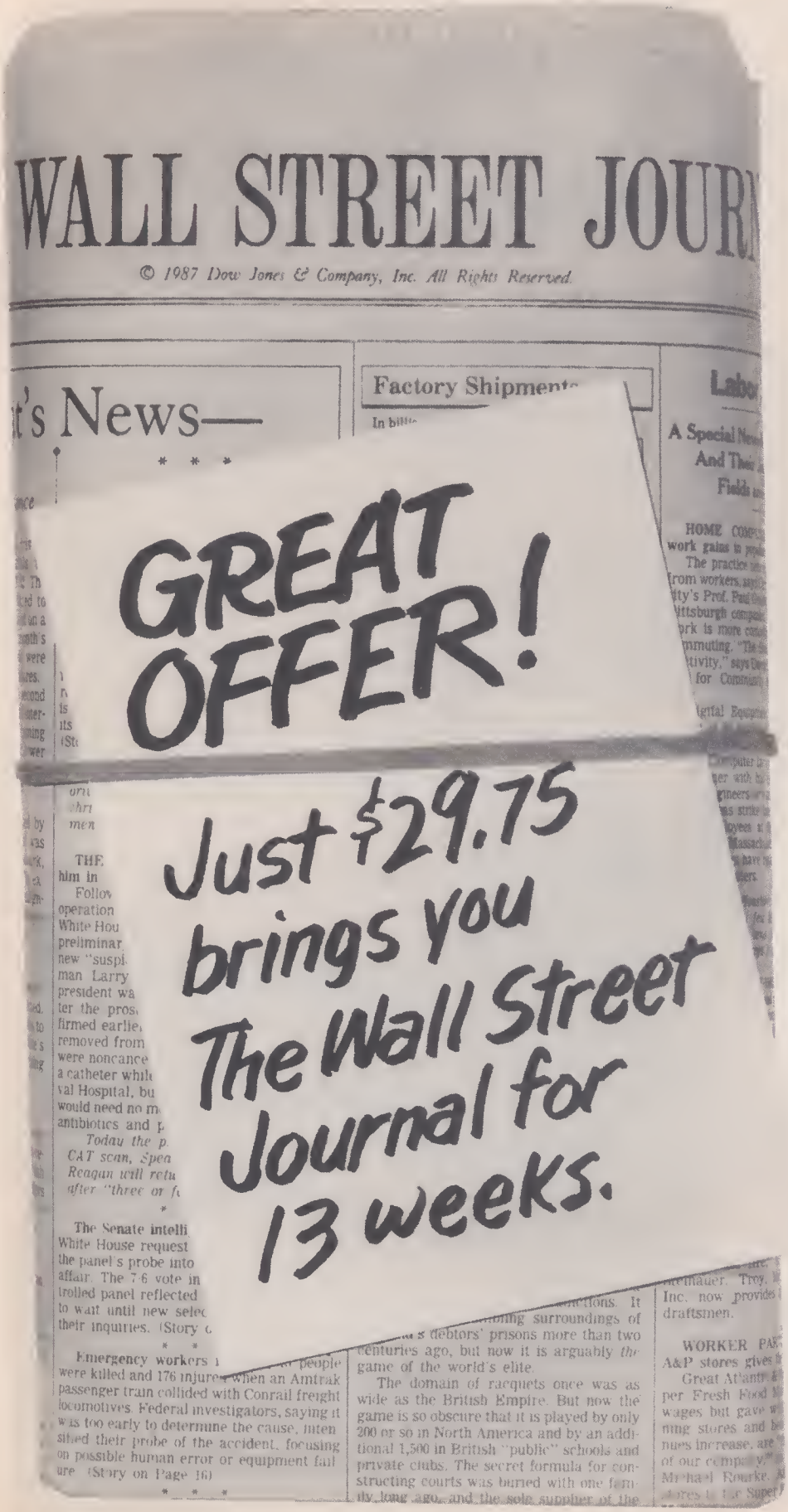
TOM LULEVITCH

Executive Support Systems:
The Emergence of Top Management Computer Use, by John F. Rockart and David W. DeLong.
Dow Jones-Irwin. 288 pages. $29.95.

Working from studies conducted at the Center for Information Systems Research (CISR) at the Massachusetts Institute of Technology's Sloan School of Management, CISR director Rockart and research associate DeLong discuss the use of computers for office support and business planning and control. Computers in the executive suite are still a source of some controversy, and the authors look at ways to anticipate and manage organizational resistance. The book is marred by a somewhat dry, academic style: "Spreadsheet capabilities (e.g. Lotus 1-2-3) are another common feature found in OS-based ESS." And the copious end-of-chapter footnotes will seem an intrusion to business-oriented readers. Even so, this is a valuable look at the extent to which computers are just starting to transform the way executives do business—a situation that, properly analyzed, may present widespread opportunities to manufacturers and marketers prepared to target executive computer use as a growth field now, before it has fully hit its stride.

Japanese-Style Management:
An Insider's Analysis
by Keitaro Hasegawa.
Kodansha International.
174 pages. $18.95.

Demythologizing Japanese-style management through his long experience with it, Hasegawa, who is widely regarded as Japan's leading management and economic journalist, points out that "lifetime employment" is more a goal than a guarantee—and that the seniority system that is designed to encourage workers to stay at one company is also more a rule of thumb than a mandate. A key to Japanese management success, Hasegawa writes, is fairness in promoting employees: "When someone is promoted, the decision will be considered fair only if that person is recognized for his ability by a majority of co-workers. . . .This takes time." And since Japanese companies take a decidedly longer view than do U.S. ones, time may be on Japan's side. Indeed, Hasegawa's urging to U.S. managers—"Don't be fenced in by short-term considerations. . . . Managers . . . should not allow their company strategies to be swayed by every fluctuation in stock prices"—is likely to fall on ears that are not so much deaf as attuned to a different sort of sound. Yet many U.S. companies would be considerably improved by accepting just one of his recommendations: "Treasure your employees." ■



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Copyrighting Technology

ARE WE ASKING THE RIGHT QUESTIONS?

■ **By Stuart R. Hemphill**

PROTECTING software with copyrights has created a great deal of controversy over the last few years, but the argument may be missing the broader problem. The real question is whether copyright protection is appropriate for technology in the first place. Copyright law was designed to protect works of art, not technology, which was supposed to be protected by patents. The breakdown of that distinction is causing problems for both creators and users of technology.

Technology used to involve mechanical, chemical, and electrical structures—tangible things producing tangible results. But today, technology increasingly involves information, not objects. In the information sciences, a scientist may act more like an author than an engineer, so it's not surprising that information-oriented technology companies have turned to copyright law for protection.

MARK KSENIAK

Copyrights, however, don't protect ideas, procedures, discoveries, or facts. Authors are entitled to protect only their particular expressions of an idea. Like other forms of intellectual-property law, copyrights must balance the economic incentive of exclusive rights awarded to authors against the appropriate limits on those rights. Later authors must have the opportunity to study and build on the work of earlier authors to make their own contributions. Progress in both art and technology depends on this principle.

Whereas patents give broad exclusive rights to make, use, or sell a work, copyrights have traditionally protected their holders only against specific commercial uses. As long as they don't reproduce the source material, pharmacists can make medicines as specified in a book, and engineers are free to build machines from published plans.

Computer programs have thoroughly disrupted the comfortable assumption that ideas, procedures, and methods can be separated from expressions. The distinction between an unprotectable idea or method and a protectable expression is becoming more elusive.

Software is bringing technology copyrights into focus, but other issues loom. Biological systems and biochemical structures are now recognized as carrying information; genes and other molecules can be "written" in codes. Not only can this coded information be deciphered and written down on paper in symbolic form, it can also be copied in either its biological or symbolic form. Some have suggested that such coded information may be copyrightable.

Biotechnology poses even more difficult problems for copyright law. Does the first team to transcribe a sequence of coded biological information become the author and copyright owner, or is the code an unprotectable method, fact, or discovery? Has a copy been made when this biological information is reproduced, not from the paper or computer tape where it's stored, but in a test tube? If short strings of biological information are deemed unprotectable, does a mapping of the entire human gene system become a copyrightable compilation, like a phone book?

There are no reported legal decisions in this area yet, but the economic issues for the biotech industry and social issues for society are so sensitive that cases can be expected soon.

In general, it seems wise to extend copyright law to cover such technological properties. We need some form of intellectual property rights, however imperfect, to justify investment, and certain scientific advances cannot be easily or effectively protected in other ways. But business interests must be prepared to compromise, recognizing that copyright protection outlasts patents and has traditionally not protected broad concepts. Expansive copyright protection can retard progress by awarding too much power to the first author.

Over the years, copyright law has evolved exclusive rights for different types of works. It has also developed compulsory licenses and other dispensations for certain uses of copyrighted works, and the flexible concept of fair use. All of these legal rules should be tailored by the courts, or adjusted through legislation, to create rules that encourage not only the first venturers into a technical field, but also those that come later with improvements.

The constitutional mandate underlying all intellectual-property law is to promote the progress of science and useful arts. In today's global marketplace, an intelligent legal framework is critical to international competitiveness. Those countries that encourage business to advance science will have an edge over countries that don't. ■

Stuart R. Hemphill is a partner at Dorsey & Whitney in Minneapolis, specializing in intellectual-property law.

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RISC-y Business

Simplified chips are hot tickets to a closed industry

BY HERB BRODY

JUST WHEN IT looked as if the dust had settled, another whirlwind is shaking up the business of making microprocessors—the intricate computer chips that serve as the brains for everything from engineering workstations to car engines to microwave ovens. Not long ago, it looked as if Intel had secured market supremacy by supplying chips for IBM's hugely popular family of personal computers. Second place went to Motorola, which makes chips for Apple Computer's machines.

But a new technology called RISC—reduced instruction-set computing—threatens to topple that order. RISC microprocessors use a radically simplified design that boosts computing speed by several times (see "Basic RISC," p. 20).

RISC has swept onto the scene amid hype not unlike that which surrounded artificial intelligence in the mid-1980s. Companies are drooling over forecasts that show sales of these processors rising steeply for the next five years. Sales were only $17 million in 1987, but by 1992 RISC chips will reap more than $400 million, accounting for almost one of every three high-performance microprocessors sold, according to the market-research organization Dataquest. (High performance here is defined as those devices that crunch data in increments of 32 bits.)

No chipmaker can claim its RISC processor is compatible with its earlier chips, so new contenders have entered on an equal footing with Motorola and Intel. RISC "allows new players a shot at the market," says industry analyst Mona Eraiba, vice president for research at Salomon Brothers.

The have-nots of the chip business have staked their futures on RISC. If they succeed, such companies will profoundly alter the industry. "RISC will refragment the microprocessor market," says semiconductor analyst Stuart Johnson at the investment-banking firm of Wertheim Schroder. For chipmakers that have struggled in the shadow of Motorola and Intel—most prominently Advanced Micro Devices—RISC is a shot at the big time.

Until just six months ago, the push for RISC came from computer makers. The technology's promise of faster computing at little or no additional cost spawned RISC products from IBM, Sun Microsystems, Apollo Computer, and Hewlett-Packard. Chipmakers had not yet introduced any RISC processors, so these manufacturers had to develop their own proprietary versions. Sun Microsystems, in particular, has made RISC a key component of its business; seeking to set a standard, the company has licensed four chipmakers to produce its RISC processor. IBM essentially invented the concept behind RISC—reduced instruction sets—but has stumbled badly in its attempt to commercialize its brainchild with the RT line of personal computers (see "The RISC That Failed," p. 23).

Now, however, the chipmakers are catching up. Hoping to overwhelm the

ILLUSTRATIONS BY ED SDYKA

Imagine if, to be understood, you had to be fluent in Greek, Latin, and Old English as well as modern English. Today's microprocessors face a similar challenge. These devices must contain within their jungle of transistors the circuitry needed to execute a long list of computer instructions, including archaic ones dating back to the first microprocessors of the 1970s.

These elaborate instruction sets have been carried forward through successive generations of chips so that software written for an old chip would also work on a new one. As a result, advanced chips such as Intel's 80386 still carry the instructions of earlier generations—baggage that slows them down and increases their size and cost.

RISC—reduced instruction-set computing—wipes the slate clean. A RISC processor is wired for only the few most commonly used instructions, such as "add two numbers." The chip executes these simple commands repeatedly and in varying combinations to accomplish much the same work as a conventional processor, which is called a complex instruction-set computing (CISC) chip. A RISC chip executes one instruction during each tick of the computer's clock; conventional processors take as many as 10 clock cycles to execute a single complex instruction.

Speed comparisons can be misleading, however. A CISC processor does more work with each complex instruction than a RISC chip does with a simple one. But even though the RISC chip requires more total instructions than the CISC chip does, the RISC chip wins the race because it executes its simple instructions more quickly.

RISC chips have no earlier generation to worry about, so they don't carry the microcode baggage of a CISC chip. But this freedom raises other problems. A RISC processor can zip along at top speed only if surrounding circuitry feeds it information fast enough. Therefore, RISC-based computers require ultrafast memory chips that drive up the overall system cost.

RISC also relies on a complex piece of software called an optimizing compiler. This program translates the programmer's code into the 1s and 0s that make the silicon do its stuff. Because the RISC chip has a limited repertoire of instructions, its speed depends heavily on the optimizing compiler's efficiency.

BASIC RISC

newer players with their reputations as stable, large-volume suppliers, Intel, Motorola, and Advanced Micro Devices have all introduced RISC chips within the last six months.

The irony of RISC is that its radical nature, which makes it fast, also makes it incompatible with existing software. No RISC-based computer can run Lotus 1-2-3, or any program written for a non-RISC computer, unless the program is "recompiled"—a process that can be difficult and expensive. As a result, software producers are uneasy about the technology, because it will require them to offer programs in both RISC and conventional versions. Meanwhile, computer makers must decide whether RISC's improved performance warrants abandoning the enormous base of software already in use.

The fate of RISC is closely linked to another computer-industry trend: the growing prominence of the Unix operating system. Unlike the MS-DOS operating system used in IBM PC-compatible computers, which works only with Intel's chips, Unix can run on several kinds of processors, including RISC chips. (An operating system controls the flow of information among the central processor, memory, display, keyboard, and disk.) Moreover, most Unix software is written in a programming language called C, which is ideal for RISC processors.

But RISC companies cannot rely on Unix; only about 100,000 Unix computers were sold last year, most based on proprietary chips. As a result, "There's no market in [selling] RISC chips for Unix boxes," says Ben Anixter, vice president for marketing at Advanced Micro Devices.

Not surprisingly, RISC chipmakers are forming strategies to sidestep the thorny issue of software compatibility. The most popular tactic involves positioning the devices as embedded controllers—computer chips that control a variety of electronic equipment. Such microcontrollers are typically programmed when built and rarely reprogrammed by the user. In this niche, RISC chips face a more hospitable market because they do not make existing commercial software obsolete. "In applications where it's not important to protect a software base, customers [will] look to other microprocessors," including RISC chips, says Wertheim Schroder's Johnson.

A RISC-based controller could speed up a laser printer, sharpen the resolution of personal-computer graphics, or direct the flow of high-speed data in a computer network. (The inexpensive controller chips now found in car engines, microwave ovens, and other mass-produced products have little need for RISC's power.)

The foremost proponent of RISC controllers is Intel, whose conventional chips form the brains of most IBM-compatible personal computers. The company has not done as well in embedded controllers, however, and views RISC as a chance to conquer new territory without cannibalizing sales of its conventional chips.

Unlike other chipmakers, which trumpet RISC as a revolutionary advance, Intel tries to dodge the buzzword. "RISC is not a class of device, but rather a design technique," says product-line manager William Rash. Therefore, says Rash, Intel can use RISC to improve its conventional chips, such as the 80386, without abandoning the enormous body of software that has been written for it. By contrast, other companies view the technology as a crowbar with which to pry open the doors of the chip business.

Intel will be up against tough competition in the embedded-controller market, however. The most formidable

THE RISC TAKERS

MAKERS OF RISC CHIPS ARE BUILDING SPHERES OF INFLUENCE IN THE ELECTRONICS INDUSTRY

SPHERE 1: SUN

Workstation-maker Sun Microsystems champions SPARC technology. Four semiconductor houses will make these chips, and six companies expect to build SPARC-based computers.

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Blue Bell, PA 19424
(215) 542-4011

Xerox
800 Long Ridge Rd.
Stamford, CT 06902
(203) 929-8700

SPHERE 2: MOTOROLA

Semiconductor giant Motorola introduced its 88000 RISC processor this spring, and already has three takers. A consortium called 88Open will promote the chip.

CHIPMAKER

Motorola
6501 William Cannon Dr. W.
Austin, TX 78735
(800) 441-2447

COMPUTER MAKERS

Data General
4400 Computer Dr.
Westboro, MA 01850
(508) 366-8911

Tektronix
Box 1000, M.S. 63-635
Wilsonville, OR 97070
(503) 682-3411

Stratus Computer
55 Fairbanks Blvd.
Marlboro, MA 01752
(508) 460-2000

BOOSTER

88Open Consortium Ltd.
55 Stratham Heights Rd.
Stratham, NH 03885
(603) 778-3001

SPHERE 3: MIPS

MIPS Computer Systems has licensed its RISC design to three small chipmakers, and a dozen companies plan to develop computers based on the MIPS chip.

CHIPMAKERS

Integrated Device Technology
3236 Scott Blvd.
Santa Clara, CA 95052
(408) 727-6116

LSI Logic
1551 McCarthy Blvd.
Milpitas, CA 95035
(408) 433-8000

Performance Semiconductor
610 E. Weddell Dr.
Sunnyvale, CA 94089
(408) 734-8200

COMPUTER MAKERS

Ardent Computers
550 Del Rey Ave.
Sunnyvale, CA 94086
(408) 732-0400

MIPS Computer Systems
930 Arques Ave.
Sunnyvale, CA 94086
(408) 720-1700

Prime Computer
Prime Park
Natick, MA 01760
(508) 655-8000

Racal Redac
Tewkesbury, Glos.
GL20 8HE, U.K.
(0684) 294-161

RC Computers
1 Lautrupbjerg, 2750
Ballerup, Denmark
45-2-65-80-000

Ralm Mil-Spec Computers
1 River Oaks Place
San Jose, CA 95134
(408) 432-8000

Seiko
1-1, Akanehama 1-Chame
Narashino-shi
Chiba 275, Japan
06-305-4020

Silican Graphics
2011 Stern Rd.
Mountain View, CA 94039
(415) 960-1980

Sumitomo Electric Industries
1-3, Shimaya, Konohana-ku
Osaka, Japan
(415) 960-1980

Tandem Computers
19191 Vallco Pkwy.
Cupertino, CA 95014
(408) 725-6000

TIS Ltd.
1 Station Rd., Bourne End
Bucks SL8 5QF, U.K.
(06285) 2499

Whitechapel Computer*
200 West 78th St.
New York, NY 10024
(516) 286-8537

OTHER RISC PLAYERS

Several companies are marketing RISC chips as controllers for electronic equipment. At least three companies build computers using proprietary RISC chips.

CHIPMAKERS

Advanced Micro Devices
901 Thompson Place
Sunnyvale, CA 94088
(408) 732-2400

Horris Semiconductor
Box 883
Melbourne, FL 32901
(305) 724-7000

Intel
3065 Bowers Ave.
Santa Clara, CA 95051
(408) 765-8080

Intergraph
2400 Geng Rd.
Palo Alto, CA 94303
(415) 494-8800

VLSI Technology
1109 McKay Dr.
San Jose, CA 95131
(408) 434-3000

COMPUTER MAKERS

Apollo Computer
330 Billerica Rd.
Chelmsford, MA 01824
(508) 256-6600

Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94303
(415) 857-1501

IBM Information Systems
900 King St.
Rye Brook, NY 10573
(914) 934-4000

*in receivership

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

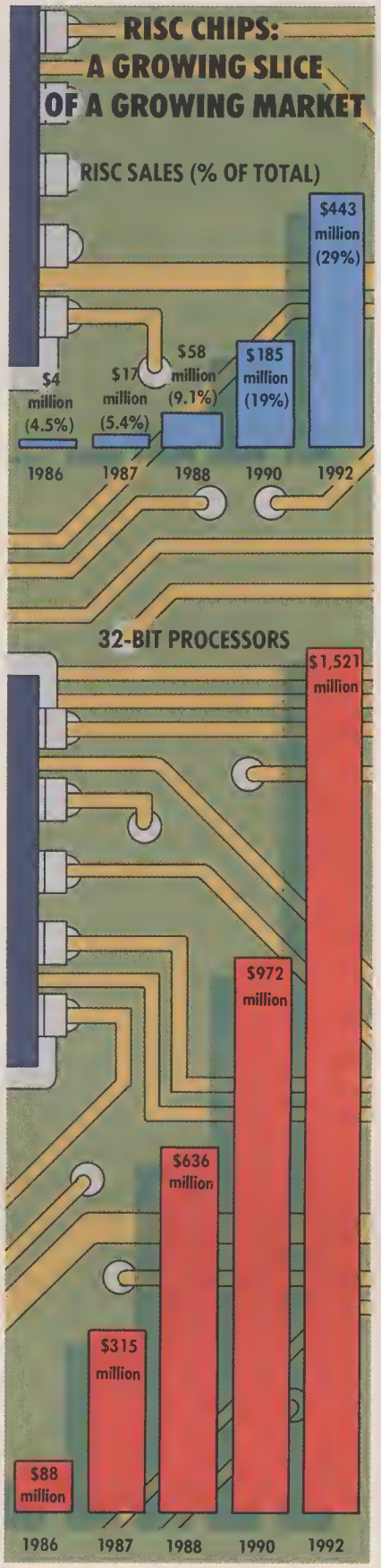
challenge will probably come from Advanced Micro Devices, which began shipping its Model 29000 RISC processor in May. Motorola and Intel will not start mass-producing RISC products until late this year or early 1989.

Although embedded controllers represent an immediate market for RISC processors, chip companies still hungrily eye the technology's potential in high-end workstations. Ultimately, they reason, high-performance computers will need RISC, forcing a software base to develop. "Moving to RISC gives a computer maker a gain in performance equivalent to jumping two years into the future," says computer researcher Mark Auslander of IBM's Watson Research Laboratory in Yorktown Heights, N.Y.

Figuring there's safety in numbers, companies are forming a variety of partnerships to bring RISC to market. Sun Microsystems, which developed a RISC device to run its powerful workstations, does not manufacture microprocessors. The company has licensed four chipmakers to build versions of its RISC processor, dubbed SPARC (for scalable processor architecture). Japan's Fujitsu introduced the first SPARC chip last year; three U.S. semiconductor houses—Cypress Semiconductor, Bipolar Integrated Technology, and LSI Logic—will follow this year. Although Sun's licensees will conform to the overall SPARC design, they will be free to add unique features to their products. This will result in many flavors of SPARC, all running the same software but differing in speed and price.

In pushing SPARC, Sun may have backed itself into a corner. The natural market for SPARC chips lies with rival workstation makers, who are loath to adopt a design that Sun controls. Indeed, Apollo is building a new line of workstations around its proprietary version of RISC, called PRISM (for parallel reduced instruction set multiprocessing). Companies that have announced plans to offer SPARC-based systems—AT&T, Unisys, and Xerox—are widely considered to be workstation also-rans who see the chip as a relatively painless way to enter the market.

Another RISC team is forming around MIPS Computer Systems. MIPS was formed in 1984 as a chipmaker, having developed a RISC processor. Now the company is angling to become a computer-systems supplier. Like Sun, MIPS has licensed its RISC design to several small chipmakers. So far, MIPS has enlisted Integrated Device Technology, Performance Semiconductor, and LSI Logic, which has also licensed the Sun chip.



By signing agreements with both Sun and MIPS, LSI Logic aims to marry RISC with what has lately been the hottest segment of the semiconductor business: application-specific integrated circuits, or ASICs. These chips combine on one piece of silicon just those circuit elements that will be needed for the particular product the chip will wind up in. Whereas other companies licensing technology from Sun and MIPS plan to mass-produce general-purpose RISC chips, LSI Logic intends to add such chips to the battery of devices it can place in an ASIC.

RISC also presents LSI Logic with the long-awaited opportunity to add microprocessors to its repertoire. The value of an ASIC vendor lies largely in its flexibility—how many different chip designs it can produce on short notice. LSI Logic lacked the resources to develop its own processor, and neither Motorola nor Intel was interested in divulging its family jewels to the small company. "We had a lot to lose if we did not ASIC-ize a microprocessor," says LSI Logic vice president Bruce Entin, who expects RISC sales to account for as much as a quarter of his company's business by 1991.

LSI Logic will not be alone in marrying RISC to ASICs. VLSI Technology is marketing a low-cost RISC chip that it claims is ideal for ASICs; the chip is smaller and less expensive than competing units, leaving room to surround it with lots of other circuitry. VLSI Technology gained considerable manufacturing and market clout this spring by signing Sanyo, the Japanese electronics giant, as a second source for its RISC product.

In a key development, RISC teams are also forming on the software side of the aisle. Support from software suppliers is crucial if RISC is to penetrate the market, because RISC-based computers won't sell unless software exists to put them to work.

In March, for example, MIPS Computer Systems and its chipmaking licensees launched a company called Synthesis Software Solutions to ensure

MATT ZANG

THE RISC THAT FAILED

IBM invented RISC, but then drew yawns with its first RISC machine, the RT personal computer. Introduced in 1986 as a workstation for scientists and engineers, the RT has seen its sales eclipsed by those of more powerful workstations from Sun Microsystems, Apollo Computer, and Hewlett-Packard.

The RT's poor showing should be blamed not on RISC, but on the lack of a coherent marketing strategy, according to Charles Foundyller, president of Daratech, a market-research firm in Cambridge, Mass. He says the machine lacked a corporate advocate—someone with a vision of what it should become. Though developed by IBM's Applications Systems Division, the RT is produced by the Entry Systems Division, which makes personal computers.

More importantly, say several analysts, the RT simply lacks the computing performance that high-end users crave. "The RT came out early and was not competitive," says computer analyst Andrew Rappaport of Boston's Technology Research Group. "IBM was a dollar long and a MIPS short," agrees Foundyller. MIPS, or millions of instructions per second, are the most common gauge of workstation power.

Some users say the RT has even failed to live up to its modest claims. The machine "is definitely not as fast as IBM says it is," says Christopher Durham, who runs a network at Carnegie-Mellon University linking RTs to each other and to a central host computer.

Even some at IBM will admit that the RT is not a world-beater. Computer researcher Marc Auslander at IBM's lab in Yorktown Heights, N.Y., who was involved in the lab's pioneering work on RISC in the 1970s, barely disguises his disdain for the RT. The machine is merely "an early attempt" at RISC, he says. "It doesn't use all the ideas we developed."

Don't count IBM out of the RISC race, however. Newer versions of the RT fix some of the computer's earlier shortcomings. As Foundyller says, "The fat lady's not even on the stage yet."

that programs are available for its computers. Synthesis Software Solutions buys popular software packages and converts them for use on the MIPS computer, in hopes of driving down software costs. The strategy seems to be succeeding. In May, four software vendors—Applix, Relational Technology, Unify, and Network Innovations—slashed the prices for software running on the MIPS RISC-based computer by as much as 90 percent.

Rising to challenge the Sun and MIPS teams is semiconductor giant Motorola, which this spring introduced a RISC chip called the 88000. Drew Peck, an analyst at Donaldson Lufkin Jenrette, calls the 88000 a "tour de force of RISC technology." To promote its new chip, Motorola has launched a consortium of users called 88Open. By mid-May, this nonprofit organization had enlisted 28 members, including Data General, Tektronix, and Convergent Technologies.

Ultimately, says 88Open's executive director, Roger C. Cady, software written for any 88000-based machine will run, without revision, on any other computer using that processor. The consortium also plans to standardize the "look and feel" of 88000-based programs, much as Apple Computer has done with the Macintosh. In other words, every program that runs on an 88000 computer will use the same type of commands and control screens.

Motorola is learning from its mistakes. The company's flagship processor, the 68000, hindered standardization because it didn't include enough circuitry. Anyone building a 68000-based computer must add proprietary devices to make up for the missing pieces, and that fact has kept various brands of 68000-based computers from using the same software. A program written for a Sun workstation, for example, must be recompiled to run on an Apollo workstation, even though both machines use the 68000 chip.

If 88Open succeeds, software will be interchangeable among 88000-based computers. Software producers will be able to offer a single version of each program, and computer makers will point to this large software library to sell systems.

Initially, Motorola is slapping a high price on the 88000, largely to defend its conventional microprocessors. The company expects to sell about six million 68000 chips this year. However, it's unlikely that such protectionism will last. Customers expect prices to plummet once manufacturing volumes increase and quality problems are solved. Motorola "may be shooting itself in the foot" with its high pricing, says Peck of Donaldson Lufkin Jenrette.

Advances in computer hardware have usually outpaced the software that can take advantage of them, and RISC is no exception. John East, senior vice president at Advanced Micro Devices, compares the situation to the arrival of the first automobiles 100 years ago. Back then, East notes, travelers could come across bales of hay everywhere they went, but would search in vain for a gas station.

For most business people, RISC may seem just another brand of magic. And in one sense, it matters little to someone sitting at the keyboard how many binary instructions are hard-wired onto the sliver of silicon under the hood. But RISC is not just another acronym coined by computer makers to differentiate their wares. It's a force that promises—or threatens, depending on one's outlook—to reshape an industry.

That's a RISC worth taking. ■

Computer Marketing

Europe's Barriers Crumble

Impending changes in the European trade equation promise to intensify the lucrative battle for market dominance overseas

BY FREDERICK V. GUTERL

IMAGINE A WORLD in which a major computer company such as NCR Corp. sold minicomputers as fast as it could make them in its home state of Ohio, but was virtually shut out in California. It just wouldn't make sense. Yet nobody blinked last year when Nixdorf Computer AG sold about $1.6-billion worth of minicomputers in its native West Germany but less than $200-million worth in the United Kingdom, even though the two markets are not that different in size.

The European computer market's pastiche of trade levies, customs export documents, and language-translation headaches conspires to keep the marketplace warped and fragmented. Yet in the last few years, that often incoherent marketplace has become surprisingly lucrative for U.S. computer companies. For one thing, Europe has embarked on an enormous economic upheaval in recent years—leading up to the impending destruction of long-standing trade barriers—that has fueled a seemingly insatiable demand for computers. U.S. companies are stepping in to help fill that demand. The falling U.S. dollar has given American suppliers a leg up on continental firms. Compared to Japan, where intense cultural differences continue to stymie most U.S. computer makers, Europe is a cakewalk.

Although the weak dollar has helped make U.S. firms competitive, it will not assure their success indefinitely. Indeed, the competition for European business is rapidly intensifying. Formerly sheltered European firms have begun to whip themselves into shape, while others are teaming with competitors to form continent-wide joint ventures. Powerful Japanese computer companies have also stepped up their efforts in Europe. The European computer market of the 1990s may not be such an easy target.

For the present, though, U.S. computer companies are cleaning up. Hewlett-Packard Corp. boosted its European sales 22 percent last year, from $2.2 billion in 1986 to $2.7 billion in 1987. The company's U.S. growth rate in orders was 13 percent, hitting $4.26 billion last year. Unisys posted just 6 percent worldwide growth in revenue last year, but its European revenue jumped 20 percent, from $2.1 billion in 1986 to $2.5 billion in 1987. Hard-charging Compaq Computer Corp., which has added five European subsidiaries in the last two years, reported 170 percent growth in European sales, to $415 million in 1987.

DAVID BIEDRZYCKI

"We are committed to increasing the contributions of our European operations to our total revenue," says Compaq president Rod Canion.

This ballooning revenue from Europe is due in part to the falling value of the U.S. dollar relative to European and Japanese currencies. Since trading at its high two years ago of 250 Japanese yen, the value of the dollar has been cut in half, to about 125 yen. The fall has been just as steep against the West German deutsche mark; the exchange rate has slipped from 3.47 marks to the dollar in February 1985 to roughly 1.7 marks to the dollar in early June. Currency valuations vary from country to country, but the dollar is lower against most countries in the European monetary system, where values are tied to the deutsche mark.

Because the major U.S. computer companies have manufacturing plants in Europe, they cannot reap all the benefits of the dollar's fall. But larger operations still enjoy savings on the 35 to 50 percent of their costs they incur in dollars. Smaller operations, which generally don't have European manufacturing facilities, save even more. On the return side, the currency situation has inflated the bottom-line value of foreign sales for U.S. manufacturers, increasing their profit margins and their competitiveness against European and Japanese rivals.

However, U.S. companies may not be making the most of the opportunities presented by the weak dollar. Unlike Japanese companies, which used the weak yen of the early 1980s to grab market share by cutting prices, many U.S. computer makers have concentrated on pumping up short-term profits. Analysts say U.S. firms, so far, are trying to hold their local-currency prices steady while letting the depreciating dollar pad the bottom line. This tactic

THE BATTLE FOR EUROPE 1987

Many of the following figures are estimates, and growth rates have not been corrected for currency fluctuations.

**Honeywell-Bull had combined mainframe and minicomputer revenues of $1.05 billion in 1987; breakdowns are not available.*

MINICOMPUTERS*

	REVENUE	GROWTH
IBM	$4.9 billion	16%
Digital Equipment	$3.2 billion	44%
Nixdorf	$2.7 billion	16%
NCR	$1.8 billion	30%
Olivetti	$1.8 billion	11%
Hewlett-Packard	$1.7 billion	27%
International Computers	$1.2 billion	15%
Unisys	$750 million	20%

looks great on quarterly reports, but may not be the best way to gain long-term market domination. If and when the dollar recovers and their cost advantage evaporates, companies that take their profits now could have trouble holding their ground against newly competitive local suppliers.

European prices for U.S. computers have come down somewhat, but observers report that some companies are selling their computers overseas for 10 to 20 percent more than they charge domestic customers. The $11-million IBM 3090 mainframe, for instance, currently costs about $2 million more in Europe than in the United States, driving some big European corporate customers to buy their mainframes stateside and ship them across the Atlantic, says Philip G. Fearnhead, a computer analyst at Kleinwort Grieveson Securities Ltd. in London. He estimates that 10 to 15 percent of new 3090s in Europe are now bought this way.

The weak dollar is only part of the story, however. The continent's generally strong economy has fueled an equally strong increase in computer demand. Europe's mid-range computer market is growing at 10 percent a year in local currencies—almost 28 percent a year when computed in dollars—versus about 5 percent growth in the United States, according to research from Dataquest. The personal-computer market is rising 30 percent a year—more than 50 percent a year in dollars—which is twice as fast as in the United States. The mainframe market is expanding much more slowly, at only about 4 percent per year.

Just as important, Europe's computer demand has avoided the boom and bust pattern that has plagued the U.S. market. The initial buying frenzy that introduced personal computers to America in the early 1980s later collapsed into a prolonged slump, and is only now lurching forward again. Capital spending growth, considered a reliable barometer of computer purchases, languished at 0.7 percent in the United States last year, but is expected to jump to a robust 6.2 percent figure in 1988. By contrast, capital spending in Europe chugged along with a 2.8 percent growth rate in 1987, and spending should increase by 3.8 percent in 1988, according to the London investment firm of County Natwest Wood Mac.

Europe's steady growth may have something to do with its initial reluc-

WEST GERMANY
MARKET SIZE: $34 BILLION

West Germany is Europe's most difficult market to break into, according to computer executives. The highly decentralized country is run by 11 regional governments, each with its own laws and distinctive culture, and the West German market is one of the most competitive in Europe, with no clear leaders.

A few large industrial companies are the dominant corporate buyers, and the country tends to be conservative when it comes to making computer purchases, just as it is with other aspects of its economy. West Germany's capital investment growth is typically the slowest in all of Europe, increasing at a rate of less than 2 percent last year. As a result, the country's profit margins are some of the slimmest on the continent.

IBM leads the West German market in sales of mainframe computers, but second-place Siemens AG enjoys a virtual monopoly on government purchases. Another local supplier, Nixdorf, makes Unix-based minicomputers and is one of the best-performing computer companies in Europe—its profits rose 19 percent last year to $160 million on revenues of $3 billion. With over half of its sales in Germany, Nixdorf has managed to stake a firm claim on its home turf and is now turning its attention to other European markets.

FRANCE
MARKET SIZE: $29 BILLION

Historically nationalist France has long had a reputation for awarding government contracts to local companies. In the last few years, however, that policy has loosened somewhat, creating greater opportunities for U.S. computer suppliers.

Although France's overall computer market has been growing at barely 10 percent a year, Digital Equipment Corp. has enjoyed 35 percent growth in the country. It's not surprising, then, that local manufacturers have suffered. France's big national manufacturer, Groupe Bull, has seen its market share fall from first to second place in mainframes (behind IBM) and to a distant fourth in minicomputers (behind IBM, Hewlett-Packard, and Digital Equipment Corp.).

Apple Computer has done well selling personal computers in France, partly because the California company decided to put its European headquarters and factories there, and partly because of its individualistic corporate image, which is said to appeal to the French temperament. However, Apple has suffered from the French government's newfound propensity for IBM compatibility. Several big contracts have been awarded to the array of tiny French companies that make IBM-compatible personal computers instead of to Apple.

PERSONAL COMPUTERS

	REVENUE	GROWTH
IBM	$2.9 billion	11%
Olivetti	$1.1 billion	–2.4%
Apple	$606 million	57%
Compaq	$415 million	170%
Amstrad	$363 million	22%

MAINFRAMES*

	REVENUE	GROWTH
IBM	$5.2 billion	8%
Siemens	$1.5 billion	3%
Internationol Computers	$1.2 billion	10%
Unisys	$1.1 billion	6%
Comparex	$500 million	4%
Amdahl	$300 million	8%

SOURCE. DATAQUEST/HIGH TECHNOLOGY BUSINESS RESEARCH

tance to embrace newfangled computer technology. Observers estimate that European computerization trails that of the United States by about two years. "Americans are willing to make a small investment in a promising new technology, without even analyzing it, just to get into the game," says Eckhard Pfeiffer, senior vice president of Compaq Computer in Munich, West Germany. "In Europe, people study brochures for months, turn the decision around and around 15 times, [and] finish the cost-benefit analysis. By then, the decision has become as obvious as a fact."

There are signs that European customers are finally putting down the brochures and picking up the order books. Computer executives say the new willingness to buy is at least indirectly due to the combined effort by countries in the European Economic Community (EEC) to drop most of the continent's trade barriers by 1992. Within four years, the EEC plans to eliminate tariffs, customs delays, barriers to mergers and acquisitions across national boundaries, government favoritism toward domestic companies, and similar obstacles.

The prospect of massive trade liberalization has galvanized potential computer customers in a number of industries, and many are moving to computerize their operations before a predicted post-1992 shakeout. "Companies that have had a 40 percent share in their home markets suddenly will have only maybe 5 percent of the European market," forecasts Bruno d'Avanzo, vice president for European sales and marketing at Digital Equipment Corp. in Geneva. "They are worried, so they are trying to modernize and get a competitive edge."

Food producers, for example, are taking over direct management of areas of their business, such as distribution, that they formerly left to third parties. Such companies are linking purchasing, production, and distribution operations through computer networks. Specialized insurance companies are abandoning agents in favor of their own international distributors, aided by network-linked databases.

Also in the financial arena, banks intent on expanding their investment services are delegating decision-making to branch managers; this will require new systems to deliver more information to branch offices. EEC requirements for greater disclosure of financial data are

ITALY

MARKET SIZE: $16.7 BILLION

Italy's relatively immature computer market boasts one of the fastest growth rates on the continent: 15 to 20 percent annually. The country is the only one in Western Europe where IBM does not lead the market. For the time being, that honor belongs to Ing C. Olivetti, a $5.8-billion outfit headed by financier Carlo de Benedetti and well known in the U.S. for its role supplying personal computers to AT&T. Olivetti is also the second biggest personal-computer maker in Europe, trailing only IBM, and is a significant player in minicomputers as well. With its acquisition of Triumph-Adler, a West German office-equipment supplier, the Italian heavyweight is hitting hard in the German market.

Still, Olivetti derives most of its strength from the home market. With typewriter stores selling its personal computers in hundreds of villages throughout the Italian countryside, Olivetti has a unique, if somewhat bizarre, distribution system that its rivals can't match.

Distribution isn't everything, of course. Olivetti posted flat revenues last year, reflecting an across-the-board revamping of the company's products. It released new personal computers and introduced new Unix-based minicomputers to counter competition from Digital Equipment and Unisys. The weak dollar has also hurt.

SPAIN

MARKET SIZE: $5.8 BILLION

When Spain entered the European Economic Community last year, it dropped many of its protectionist trade practices and opened the doors to a torrent of investment that is fueling 25 percent yearly growth in its computer purchases. Even though Spain is not yet among the top five computer markets in Europe, observers expect the country to be among the leaders in a few years.

Banks are leading the expansion, aggressively trying to leapfrog their more technologically sophisticated European neighbors in preparation for Europe's planned trade liberalization in 1992. At present, the Spanish computer industry is dominated by two- and three-person distributorships, many selling a hodgepodge of wares.

Most major computer suppliers are opening local subsidiaries to tap the Spanish market's huge potential, and companies already in the country are expanding. Unisys has established a workstation factory in Barcelona, Compaq created a Spanish distribution subsidiary last year, and Fujitsu has broken with its practice of using third-party distributors to begin direct sales in Spain. The influx of new companies means "office space in Barcelona and Madrid is very tight," says John C. Quinlan, vice president for European sales and marketing at NCR, which recently stepped up its sales efforts in Spain.

MAPS BY JULIE SPRINGER/HTB

also expected to stimulate the demand for computers to handle the additional accounting load.

Many computer buyers downplay the significance of 1992 and point to increased competition as the biggest motivation to modernize. Even so, the climate created by the impending changes has given domestic firms more expansion options. House of Fraser PLC, a department-store chain with 74 stores in the United Kingdom, has installed a network of 2,400 point-of-sale terminals with a direct link to American Express for credit-card verification. The company is considering extending its reach beyond Great Britain and expanding its services to include debit cards and other payment conveniences. "There's no reason we couldn't link up with any financial institution in the Common Market," says Paul B. Livesey, Fraser's director of information systems.

The chase after these new markets takes much the same form as it does in the United States. Digital Equipment leads the minicomputer makers pursuing perennial leader IBM, while Compaq and Apple challenge Big Blue in personal computers. In mainframes, Siemens, International Computers Ltd., and Unisys lag far behind the world leader. But whereas U.S. computer companies distribute their sales relatively evenly across national borders, Europe still supports a major national supplier in just about every market.

The idea of a single European market is young compared to the long-standing practice of government support for domestic companies. That support shows up most often as preference in government orders, which historically make up a greater proportion of total purchases in Europe than they do in the United States. Although government buying habits are changing due to participation in the EEC, they haven't changed fast enough to avoid an even greater initial fragmentation than the U.S. computer market has experienced.

Each European market tends to be dominated first by IBM, which a few years ago became the number-one supplier in virtually every country throughout Europe, and second by the particular country's favorite domestic supplier. Smaller U.S. firms have anything but an open field.

Europe's domestic computer makers have grown a bit soft under government protection, making them vulnerable to tough international competition. But in their home markets, these companies have held on like bulldogs—at least in mainframes and high-end minicomputers, where substantial software investments slow the pace of change.

In France, Groupe Bull is a major supplier of mainframes and mid-range computers. In West Germany, Siemens AG has been a traditional supplier of mainframes, but is now second behind IBM and fast losing out to aggressive minicomputer rivals. In the United Kingdom, telecommunications concern STC PLC had to buy mainframe maker International Computers Ltd. four years ago to rescue it from bankruptcy. The Olivetti Group, which supplies AT&T with personal computers for the U.S. market, is the only major national company not to knuckle under to IBM, and remains number one in Italy.

THE EUROPEAN COMPUTER MARKET

1987

	SIZE	GROWTH
Minicomputers	$20 billion	8.5%
Personol computers	$10.2 billion	30%
Moinfromes	$9.5 billion	4%

COMPUTER PURCHASES BY COUNTRY

1987

West Germany	$34.0 billion
France	$29.0
United Kingdom	$25.3
Italy	$16.7
Hollond	$ 7.4
Switzerlond	$ 6.2
Spain	$ 5.8
Sweden	$ 5.4
Belgium	$ 4.5
Denmark	$ 3.5
Austrio	$ 3.3
Norway	$ 2.8
Finlond	$ 2.4

SOURCE: INTERNATIONAL OATA CORP.

Along with the fragmentation of the European computer market in the 1970s and early 1980s came a proliferation of proprietary data-processing standards that made the U.S. market look orderly by comparison. Only now, with a common market on the horizon, are corporate customers and EEC planners making standardization a paramount concern. "With each country supplying its own base of computers, users were feeling real frustration," says John E. Totman, director of European planning for X/Open Company Ltd., a nonprofit organization formed by leading computer makers to promote computing standards.

More so than in the United States, the Unix operating system may provide the rallying point. Although Europe has installed fewer Unix-based systems than has U.S. industry, observers contend that the number of Unix systems is growing far faster than that of non-Unix systems. "Unix is a major issue in Europe," says Dominic P.M. Pearce, European technology analyst for County Natwest. "I would say that almost all new systems being launched now are Unix based."

The fact that X/Open was formed by European manufacturers—Groupe Bull, Siemens, Nixdorf, Olivetti, and International Computers—before it was expanded to include major manufacturers from the United States and Japan (but not IBM) illustrates the importance of Unix to European computer companies. Indeed, the companies that specialize in Unix have found the AT&T-developed operating system to be one of the best calling cards in Europe: DEC, Unisys, and NCR have all used Unix to increase their European market share.

The growth in demand for Unix is not lost on local players, either. Olivetti recently launched a new line of dedicated Unix minicomputers to fill what it perceives to be a market vacuum. A successful line of Unix-based minicomputers has let Nixdorf match the growth of its U.S. rivals—without the benefit of currency depreciation. "Unix is the driving force of our growth," says vice chairman Arno Bohn. "People using it can decide more quickly to invest in large software programs."

Only IBM's absence casts doubt on Unix's future, and the company's leadership in the Open Software Foundation, which recently announced plans to develop an alternative version of Unix, could further cloud the situation. County Natwest's Pearce says this new consortium, which includes DEC and five

other industry heavyweights, will expand the time frame for adoption of an industry standard.

Other observers see the consortium as the latest step in IBM's awkward dance toward endorsing Unix. The company has thrown its weight behind Posix, a Unix-like interface. But in Japan, where IBM trails market leader NEC, Big Blue has abandoned its traditional haughtiness and offered to integrate its computers with those of other manufacturers. "People say IBM is trying to muddy the waters, but I think it's ultimately going to have to accept Unix," says Pearce.

If Unix is emerging as a standard for mid-sized systems, the mainframe market in Europe lacks any standard except that imposed by IBM's estimated 55 percent market share. But despite this dominance, Europeans have shown a distinct propensity to buy IBM-compatible mainframes from companies other than IBM, especially Japan's Fujitsu Ltd. and Hitachi Ltd.

International Computers' mainframes use Fujitsu processors, which represent about half the value of the final product. Siemens and BASF AG have formed a joint venture called Comparex Information Systems GmbH, based in West Germany, to sell Fujitsu mainframes in Europe. But according to a company spokesman, Siemens is considering selling its interest in the venture to concentrate on computers using its own proprietary operating system.

"IBM has a good corporate image, but at the end of the day there's always a nagging doubt," says Fearnhead of Kleinwort Grieveson. "There's a feeling that you'd better keep IBM on its toes. After all, IBM is a foreign company in Europe, and so is Fujitsu, so who cares which one you buy from? People [here] are much more open to setting Fujitsu and Hitachi systems alongside their IBM system."

In personal computers, IBM dominates the market, but other companies have enjoyed success selling compatible equipment. A captive home market, good marketing and distribution throughout Europe, and low prices have made Italy's Olivetti the strongest challenger to IBM in personal computers, and Compaq has made rapid advances at the high end. Compaq has been investing heavily in Europe, opening almost a dozen new European subsidiaries and a factory in Scotland in the last four years. The company is now reaping the benefits from its investment: the company's European operations almost tripled last year, garnering more than $415 million in sales.

Other PC-clone manufacturers have been less active than Olivetti and Compaq in Europe, however, probably because they have been busy supplying the U.S. market. Stepping in to fill the gap are U.K.-based Amstrad Ltd., which has recently come out with a business-class clone at cut-rate prices, and Dell Computer Corp., a manufacturer in Austin, Tex., which recently floated an initial public offering. Both are planning to expand from the United Kingdom into the rest of Europe.

As the continent drops its trade barriers and moves toward standard operating systems, European suppliers may face a serious shakeout. As products become more standardized, market share will shift from protected traditional suppliers to low-cost producers.

To prepare, some major computer suppliers are forming alliances to increase their chances of survival in an increasingly competitive market. "Europe is becoming a common market, so companies are looking to make alliances with European companies," says Martin Mabbut, an analyst with Morgan Grenfell Securities Ltd. In addition to Comparex, the Siemens/BASF venture, Britain's Honeywell Information Systems Ltd. has joined with Groupe Bull and NEC to form Honeywell-Bull Ltd. NEC holds 15 percent; Honeywell and Groupe Bull each control 42.5 percent. Honeywell, however, is selling an additional part of its share to Groupe Bull.

Many observers see these alliances as the start of a trend, but so far their track record has been mixed. Comparex is small and too new to judge its performance; Honeywell-Bull also has a relatively small market share and grew at a slower-than-the-market pace of just 5 percent last year. Some observers speculate that these first alliances may represent the last desperate gasp of already struggling companies.

Many more such ventures are expected, and stronger players may soon join in. After 1992, when acquisitive computer companies get greater license to cross national boundaries, a rash of mergers may be in order. "You'll also see an acceleration of mergers between computer companies selling similar products," predicts Morgan Grenfell's Mabbut. "Right now, there's a lot of overlap." ■

UNITED KINGDOM

MARKET SIZE: $25.3 BILLION

The United Kingdom boasts perhaps the strongest economy in Europe, and that has created intense competition in the computer market. "The United Kingdom tends to be the battlefield for the computer industry in Europe," says Philip G. Fearnhead, an analyst at Kleinwort Grieveson Securities Ltd., a London-based investment firm. "European and Japanese manufacturers tend to try their products out here first in preparation for the U.S. market, and the U.S. companies tend to come here first in preparation for Europe."

Despite the relatively mature mini and mainframe markets—growing at annual rates of 12 percent and 4 percent respectively—the country lacks a strong international computer company.

The biggest is International Computers Ltd. (ICL), a $2.4-billion subsidiary of U.K. electronics and telecommunications giant STC PLC, which recently turned the corner on a string of bad financial performances. The subsidiary has been making gains selling IBM-compatible mainframes, although IBM remains the market leader. "Everyone has been thinking for years that IBM was about to come in and finish ICL off," says Chris Tucker, a Kleinwort analyst. "But they've done better than anybody expected."

In personal computers, newcomer Amstrad Computer, a $667-million company headed by flamboyant entrepreneur Alan Sugar, has been coming on strong in the business market. Even though Amstrad flubbed its first shot at the market when its 1512 personal computer developed a reputation for overheating (some users claimed the machines actually melted), the company's second try grabbed 7.5 percent of the U.K. market in its first year, according to market researcher Romtec.

Frederick V. Guterl is a freelance writer living in London. He is also a contributing editor to BusinessMonth *magazine.*

Plastics Makers Clean Up From Litter

Pressures to reduce rubbish boost companies making plastics that don't last forever

BY T. A. HEPPENHEIMER

NOW THAT MANY states have enacted bottle-deposit laws, plastic trash is the next target in the assault on litter. Plastics take hundreds of years to decompose and are piling up at an alarming rate. To combat the mess, state and national governments have begun banning some plastic products. One of the toughest bills in the country, passed by New York's Suffolk County Legislature in March, prohibits the use of foam plastic bags and containers.

This trend is opening up a new market for a handful of small companies that specialize in degradable plastics—polymers that disintegrate when exposed to sunlight or soil. Some companies are developing finished products such as garbage bags; others sell the raw materials. But each aims to capture a larger share of the polymer market, which approaches $150 billion annually in the United States.

So far, degradable polymers account for less than $100 million of that market. Small specialty companies are the dominant players. Dow, Du Pont, and Union Carbide supply some degradable resins, but most large chemical suppliers are sticking to traditional products. Basically, the degradable market is still too small for the mainstream companies to worry about.

For one thing, degradable plastics are not well suited for many products. "In food packaging, degradability would have negative effects on polymer properties needed to assure purity," says Michael Levy, environmental affairs manager for Mobil Chemical Co. He adds that the Food & Drug Administration has yet to sanction any degradable plastics for use with food. Further, he says, polystyrene, a plastic widely used to package food, cannot be made degradable with current technology.

Degradability alone won't sell in the mass consumer market, because it usually raises product costs. However, as piles of litter grow, lawmakers are becoming increasingly vexed by the staying power of plastic.

The material's chemical composition is the key to its longevity. Plastic is made up of long, chainlike molecules called polymers, which just don't break. When these molecules are bonded together into a finished product, that product resists oxidation by sunlight or digestion by bacteria—the usual way things decompose in nature.

Degradable plastics are made to decompose. Photodegradable types, which break down when exposed to prolonged sunlight, are getting the most attention because they are most useful in fighting litter. To make a plastic fall apart in sunlight, the chain of molecules is weakened by occasional links of a photosensitive chemical compound. These links break when exposed to the ultraviolet light of the sun, and the chain falls apart into short sections that disintegrate readily.

Biodegradable plastics work much the same way, except their resins are blended with a substance such as cornstarch that can be attacked by bacteria or other microorganisms in the soil. This technology works well for products such as garbage bags, which usually get buried in landfills.

Because ultraviolet light does not penetrate window glass, and microbes are most plentiful in soil, degradable plastics generally will not decay as long as they are kept indoors.

Except for the webs that hold beverage cans in a six-pack, few plastic products are regulated. Therefore, six-pack carriers represent the biggest market for degradable plastics. U.S. suppliers produce about 70 billion beer and soft-drink cans each year, which use 125 million pounds of polyethylene for carriers—a $60-million market. So far, about 30 percent of these carriers are photodegradable, due largely to environmental legislation in 11 states.

The market will probably expand as more states follow. The degradable polyethylene used in carriers costs several cents more per pound than the standard compound, so demand grows only through legislative mandate. Since 1977, about one new state per year has enacted laws requiring degradable carriers. Rhode Island senator John Chafee has introduced a bill requiring that degradable carriers be used nation-

wide, but its passage seems remote.

Even a growing market has not produced a challenger to seriously threaten the Hi-Cone Division of Illinois Tool Works Inc. Hi-Cone's $18 million in revenues from photodegradable carriers is only about 1 percent of Illinois Tool Works' total, which nearly doubled to $1.7 billion from 1985 to 1987. Hi-Cone's process is the only technology used to make degradable carriers. To date, Hi-Cone has filled all the demand for degradable six-pack carriers, but recently it licensed production rights to Owens-Illinois of Toledo, Ohio. Owens will pick up some of the demand as mandates for degradable carriers increase.

Lower cost, rather than legislation, is driving the market for biodegradable garbage bags. The Good Sense trash and leaf bags from Webster Industries have captured about 10 percent of the markets in New York City, Boston, and Hartford, Conn., where the bags are priced below name-brand competitors.

The next challenge for Webster is maintaining its growth in photodegradable garbage bags. Its disintegrating polyethylene plastic costs three to four cents per pound more to produce than nondegradable types, in part because the bags must be made of heavier plastic to assure sturdiness. Webster overcomes this handicap by using inexpensive, recycled polyethylene as a filler. However, little of the plastic is recycled, so the company's pricing strategy may soon reach its limit in the overall plastic-bag market, which uses $360-million worth of virgin polyethylene annually.

Webster is threatened by technologies that can make low-cost garbage bags without relying on recycled plastic. One challenger is Princeton Polymer Laboratories, a private contract-research company. President Donald Hudgins claims the company's photodegradable additive will reduce the cost of disintegrating plastic films because it can be used in very low concentrations—as low as 0.1 percent of the total blend. Princeton plans to license its process, and is negotiating an agreement with Phillips Petroleum.

Biodegradable plastic is a good solution for garbage bags, which don't see sunlight buried in a landfill. Guardian Poly Industries of Montreal is about to introduce bags made with cornstarch from St. Lawrence Starch Co., one of Canada's largest corn-milling companies. St. Lawrence considers plastics a major opportunity for new products. It shipped $1.6-million (Canadian) in plastic additives in 1987, mostly to Aldis of West Germany. "We're just gearing up for North American production," says business-development manager Wayne Maddever.

The process developed by St. Lawrence yields plastics that are 6 to 15 percent starch. However, these films won't rot nearly as fast as those from startup Agri-Tech Industries, which makes films with a starch content of 40 to 80 percent. Agri-Tech is not yet selling goods, but is looking for partners to develop products through joint ventures. Trash and leaf bags are among its ma-

THE NEW POWERS IN PLASTICS

COMPANY	1987 REVENUE	DEGRADABLE PRODUCTS	PROPOSED NEW PRODUCTS
Agri-Tech Industries 2004 S. Wright St. Urbana, IL 61801 (217) 244-7752	Not available. 1987 value, $250,000; raising $5 million in new capital	Mulch bags (available fall 1988)	Mulch films, tampon applicators, tableware
Ampacet 250 S. Terrace Ave. Mount Vernon, NY 10550 (914) 699-9100	$116 million	A photodegradable additive	Additional additives for plastics made from polyolefin resin
Eco 2 First Canadian Place Toronto, Ontario, Canada M5X 1E2 (416) 367-4047	Not available. 1987 stock value: $73 million	Ecalyte photodegradable plastic	Polystyrene plastic, in a joint venture with Polysar
ICI Chemicals New Murphy Rd. & Concord Pike Wilmington, DE 19897 (302) 575-3000	$136 billion	Pilot-plant production of biodegradable PHBV polyesters	Increased PH8V production for bottles, films, trash bags, fast-food containers, and tampon applicators
Ideamasters 18201 Southwest 216 St. Miami, FL 33170 (305) 252-3753	$6 million	Plastigone crop-mulch films	Time-controlled photodegradable additives
ITW Hi-Cone Division 1140 W. Bryn Mawr Ave. Itasca, IL 60143 (312) 773-9300	$18 million	Six-pack carriers	None
Princeton Polymer Laboratories 501 Plainsboro Rd. Plainsboro, NJ 08536 (609) 799-2060	Not available	A photodegradable additive, available under license	Not disclosed
St. Lawrence Starch Co. Port Credit Postal Station Mississauga, Ontario, Canada L5G 1E8 (416) 271-1258	$80 million (Canadian)	Ecostar cornstarch-based additive, used in shopping bags in Europe	Additives for trash bags and corn-syrup bottles
Webster Industries 58 Pulaski St. Peabody, MA 01960 (508) 532-2000	$170 million (for parent company, Chelsea Industries)	Garden, trash, and garbage bags	None

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

jor targets, along with crop mulches.

Grocery bags are another promising market. Because of its lower cost, plastic is rapidly replacing brown paper bags at checkout counters. Plastic bags held only 15 percent of the grocery market in 1986, but this year the share stands at 50 percent and is expected to reach 80 percent by 1990. Most of these bags are made from standard plastic, but some states, including New York, Oregon, and Washington, are considering laws requiring degradable bags. In Italy, all such packaging and wrapping must be degradable by 1991.

Eco Corp., a $7.3-million Canadian company, is moving into the grocery-bag market. Its shipments to Italy have risen from five tons in 1985 to 80 tons in 1987. Eco makes photodegradable polyethylene in a pilot plant, but wants to license its technology to larger companies. A joint venture with Polysar Inc. of Leominster, Mass., the third largest U.S. producer of polystyrene, gives Eco a foothold in the fast-food market, which uses polystyrene for packages and cups. "The potential market is absolutely phenomenal," says Anthony Redpath, Eco's vice president for technology. Grocery bags represent a $200-million market; fast-food containers account for $250 million.

Though unrelated to litter, plastic crop mulches promise another market for photodegradable plastics. Farmers currently spend about $125 million a year for nondegradable mulch films, which hold in moisture and inhibit weeds when spread between rows of vegetables. However, the black plastic films must be removed at the end of each growing season, a labor-intensive task that could be eliminated if the films disintegrated in the sun.

Two companies are zeroing in on the market. Ampacet Corp., which supplies a photodegradable additive for use in Webster's trash bags, sees mulch films as an avenue for expansion. With $116 million in 1987 sales, the private company produces more than 50,000 tons per year of color and additive concentrates. "We've had double-digit growth for five years," says Martin Fernandi, vice president of marketing.

The startup Ideamasters Inc. bought the rights to an Israeli process for additives that make plastics wither on a schedule. Depending on the blend, plastic films made with these additives will last anywhere from 30 days to a year, according to the company. That lets Ideamasters tailor mulch films both to planting schedules and to specific climates. For instance, farms in northern areas receive less sunlight and require a more sensitive formulation. President Sheldon Lantinberg has so much confidence in the concept that he plans to take the $6-million company public.

Perhaps the most novel approach to degradability is that of ICI Chemicals, a $1.36-billion producer of pharmaceuticals, plastics, and other chemical products. ICI uses bacteria that, when fed a carefully formulated diet, produce a biodegradable plastic within their cell walls. ICI is producing 100 tons per year of this plastic, called PHBV, in a pilot plant in England. However, at a cost of $15 per pound, the material is limited to very specialized markets, such as surgical implants designed to dissolve inside the body. ICI is working to drop its cost to $1.50 to $2 per pound in full-scale production, at 10,000 tons per year. At that price, the company could enter such markets as disposable diapers and tampon applicators.

Legislation remains the key to these companies' prosperity. Oregon and Washington are considering laws, similar to the New York ban, that would also address disposable diapers. New Jersey is considering a bill to require degradable egg cartons and tampon applicators, as are Vermont, West Virginia, and Hawaii. At the federal level, a bill now before Congress would direct the Environmental Protection Agency to determine whether to mandate degradability in all plastic products that could pose a threat to fish or wildlife. Such regulation would create much broader markets for degradable plastics. ■

T.A. Heppenheimer is a journalist and author specializing in high technology.

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chief of *BioVenture*
, a biotech-industry
newsletter.

IL-2 remains promising, but combining it with other treatments reduces its revenue potential, estimated at as much as $400 million a couple of years ago. "IL-2 is just one more promising drug in the cancer arsenal," says Michael Sorell, a biotech analyst with Morgan

have not given up; at least 83 clinical trials are now in progress. Whoever figures out how to tame the drug's power will have a crack at an annual market of $275 million, estimates Denise Gilbert, a biotech analyst with Montgomery Securities. At least six U.S. companies are conducting research on IL-2,

1400 53rd St. Emeryville, CA 94662 (415) 420-3300	engineering	large group	
Collaborative Research 2 Oak Park Bedford, MA 01730 (617) 275-0004	Natural growth	Phase 2: small group	None
Immunex 51 University St. Seattle, WA 98101 (206) 587-0430	Genetic engineering	Phase 3: large group	Hoffman-La Roche 340 Kingsland St. Nutley, NJ 07110 (201) 235-3315

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/PRUDENTIAL-BACHE SECURITIES

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ICI Chemicals
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(416) 271-1258

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T.A. Heppenheimer is a journalist and author specializing in high technology.

Trials of a Cancer Drug

Biotech companies race to solve the riddle of interleukin-2 as its initial promise confronts reality

BY FRANCESCA LUNZER

SAY THE phrases "cure for cancer" and "genetic engineering" in the same sentence and you'll excite people from Wall Street to Main Street. That explains the extraordinary appeal of interleukin-2 (IL-2), a drug that stimulates the body's immune system to fight cancer cells.

IL-2 has alternately been biotechnology's hero and goat. Reports in 1985 of preliminary success soon gave way to more sobering accounts. Serious side effects caused at least four deaths during clinical trials, causing both researchers and the public to question the new therapy's worth.

But biotech companies have not given up; at least 83 clinical trials are now in progress. Whoever figures out how to tame the drug's power will have a crack at an annual market of $275 million, estimates Denise Gilbert, a biotech analyst with Montgomery Securities. At least six U.S. companies are conducting research on IL-2, and two—Cetus and Hoffman-La Roche—are closing in on commercialization. Both companies could file for Food & Drug Administration approval by next year.

No one, however, still holds the notion once carried on the covers of *Fortune* and *Newsweek*—that IL-2 is a one-stop cancer breakthrough. Researchers now more realistically see the drug as beneficial in treating certain types of cancer, often in combination with conventional chemotherapy drugs. "In the long run, IL-2 will be given in different doses and in different combinations than first expected," says Cynthia Robbins-Roth, editor-in-chief of *BioVenture View*, a biotech-industry newsletter.

IL-2 remains promising, but combining it with other treatments reduces its revenue potential, estimated at as much as $400 million a couple of years ago. "IL-2 is just one more promising drug in the cancer arsenal," says Michael Sorell, a biotech analyst with Morgan

MARCHING TOWARD FDA APPROVAL

The Food & Drug Administration requires three phases of human trials before approving a new drug. Phase 1 evaluates the drug's safety, Phase 2 checks its effectiveness in a small group of patients, and Phase 3 tests its effectiveness in a larger group.

COMPANY	IL-2 PRODUCTION METHOD	FDA-TEST STATUS	MARKETING PARTNER
Amgen 1900 Oak Terrace Lane Thousand Oaks, CA 91320 (805) 499-5725	Genetic engineering	Phase 2: small group	Johnson & Johnson 1 Johnson & Johnson Plaza New Brunswick, NJ 08933 (201) 524-8590
Biogen 14 Cambridge Center Cambridge, MA 02142 (617) 864-8900	Genetic engineering	Phase 2: small group	Glaxo 5 Moore Dr., Research Triangle Park, NC 27709 (919) 248-2100
Cellcor Therapies 1256 Soldiers Field Rd. Brighton, MA 02135 (617) 782-2204	Natural growth	Phase 2: small group	None
Cel-Sci 601 Wythe St. Alexandria, VA 22314 (703) 549-5293	Natural growth	Phase 1: safety	None
Cetus 1400 53rd St. Emeryville, CA 94662 (415) 420-3300	Genetic engineering	Phase 3: large group	None
Collaborative Research 2 Oak Park Bedford, MA 01730 (617) 275-0004	Natural growth	Phase 2: small group	None
Immunex 51 University St. Seattle, WA 98101 (206) 587-0430	Genetic engineering	Phase 3: large group	Hoffman-La Roche 340 Kingsland St. Nutley, NJ 07110 (201) 235-3315

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/PRUDENTIAL-BACHE SECURITIES

Stanley and formerly a pediatric oncologist. When IL-2 was first announced, the most likely profiters were companies making the genetically engineered version; now those working on other variations have a shot at the market.

Interleukin-2 belongs to a class of proteins called lymphokines, which the body produces in tiny amounts to relay messages to the white cells that protect the body. When foreign substances threaten, lymphokines tell the white cells to attack. The body's limited supply can repel certain viruses and bacteria. Cancer, however, is a more formidable enemy, which scientists hoped could be fought with larger doses of IL-2.

Some of the earliest trials using high doses of IL-2 were conducted by Dr. Steven Rosenberg, chief of surgery at the National Cancer Institute. In some of those trials, Rosenberg administered IL-2 alone. In others, he removed white cells from the patients' blood, treated the cells with IL-2 to produce lymphokine activating killer (LAK) cells, and injected those cells into the patient along with supplemental IL-2.

Both of these methods have temporarily shrunk tumors in some people with kidney cancer and melanoma (a form of skin cancer). Success with those deadly diseases has stirred research activity; 24 cancer centers have applied to the National Cancer Institute for funds to do final-stage human testing of IL-2 alone, and of IL-2 along with LAK cells, during 1988 and 1989.

The company that has staked the most on IL-2 is Cetus Corp. IL-2 is the first genetically engineered product that Cetus is marketing on its own; the 16-year-old company has raised cash from public offerings, from a limited partnership, and by selling generic cancer drugs. IL-2 is currently Cetus' most important product.

Hoffman-La Roche has licensed IL-2 from Immunex Inc., a small biotech company that cannot afford to market the drug on its own. Immunex will produce the drug; Hoffman-La Roche will conduct tests in pursuit of regulatory approval—a process that may cost $100 million—and then market the drug.

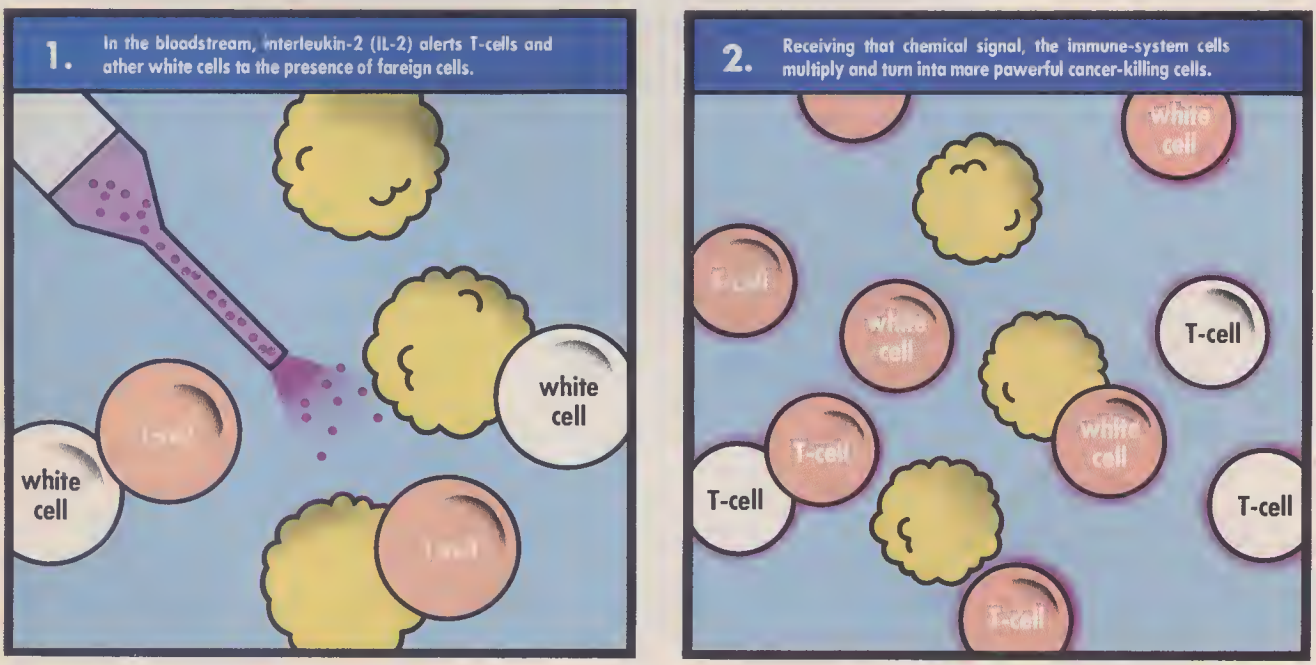
Despite earlier predictions, the first company to win a patent on genetically engineered IL-2 may not automatically exclude the competition. Hoffman-La Roche recently licensed the rights to the patent issued to Japan's Ajinomoto for genetically engineered IL-2. Cetus also has a U.S. patent on its version of IL-2, but analysts do not expect Cetus and Hoffman-La Roche to bump heads. Before approving any drug for human use, the FDA requires lengthy trials to assess safety and effectiveness. Hoffman-La Roche will probably need Cetus' clinical data to get the FDA's nod; most analysts expect the two companies to cross-license their patents and share the market.

Cetus and Hoffman-La Roche will probably file applications for FDA approval for treatments using IL-2 alone and with LAK cells. Ultimately, however, analysts expect much of the profits to come from using IL-2 in combination with more traditional therapies. "For the long term, the biggest use of IL-2 will be at a fraction of the approved dose, along with chemotherapy," says Gilbert of Montgomery Securities.

In fact, researchers keep devising variations on how to use IL-2, rekindling manufacturers' hopes that the drug will find widespread use. For example, researchers at Fox Chase Cancer Center in Philadelphia have had encouraging results using IL-2 with chemotherapy drugs to treat breast cancer that has spread.

One promising avenue involves IL-2 that is produced naturally rather than genetically engineered. Two companies, Collaborative Research Corp. and CelSci Inc., are conducting human trials with IL-2 cells that were grown in a culture rather than created by recombining genes. Natural IL-2 is more effective than the engineered version because it contains other lymphokines in addition to IL-2, says president Orrie Friedman. These extra lymphokines increase the number and power of the white blood cells that attack tumors.

HOW IL-2 FIGHTS CANCER



ELIOT BERGMAN

Collaborative Research is just beginning human trials, according to Friedman. Its technique involves taking white blood cells out of a cancer patient's blood and treating them with natural IL-2. The result is a batch of strengthened white cells, which can be reintroduced into the body.

Cellcor Therapies Inc. is developing another version of natural IL-2. The company takes cells from a cancer patient and treats them with tumor tissue to stimulate the release of lymphokines, including IL-2. When injected back into the patient, these lymphokine-rich cells start killing tumor cells, says president Michael Osband. Cellcor is testing its treatment at five medical centers around the country.

Genetic-engineering companies are responding to the successes of natural IL-2 with developments of their own. They hope to make the drug more potent so it can work at lower dosages, reducing side effects. "More is not necessarily better," says George Farrington, M.D., senior partner at the Wilkerson Group, a health-care management consulting firm in New York. "In high doses, lymphokines act in a different way than the body normally uses them, which accounts for the high toxicity."

Cetus, for example, attaches a molecule of polyethylene glycol (an inert polymer) to IL-2. Animal studies have shown that this version of the drug remains in the body longer than does untreated IL-2, making it effective at lower doses. Both Cetus and Hoffman-La Roche have been combining IL-2 with interferons—other lymphokines that can be genetically engineered.

Dosage tinkering is also an important part of the research conducted before submitting data to the FDA. In its tests, Hoffman-La Roche administers only about one-fifth as much IL-2 as is used in the National Cancer Institute trials, according to associate director of clinical investigation Daniel Levitt. Researchers at Biotherapeutics Inc., a private institute in Memphis, Tenn., have been giving IL-2 as a slow intravenous drip, delivering the drug to the body steadily instead of in the more concentrated doses of many institute trials.

Finally, there may be a better way to achieve the optimum immune response. In one promising study, Rosenberg of the National Cancer Institute has removed malignant tissue from the body and bathed it in IL-2. The tumor tissue contains natural agents called T-cells that have already mounted a weak attack on the cancer cells; IL-2 makes these T-cells more potent and plentiful.

Although Rosenberg has not published his findings on TIL-cell (for tumor-infiltrating-leukocytes) therapy, doctors at Biotherapeutics have announced success with the method. If the company succeeds with TIL-cell therapy, it will have another product in its lineup to treat cancer patients, at about $35,000 a pop. But Biotherapeutics has treated only three patients with TIL-cells; its early cries of success typify the hype that tarnished IL-2's reputation.

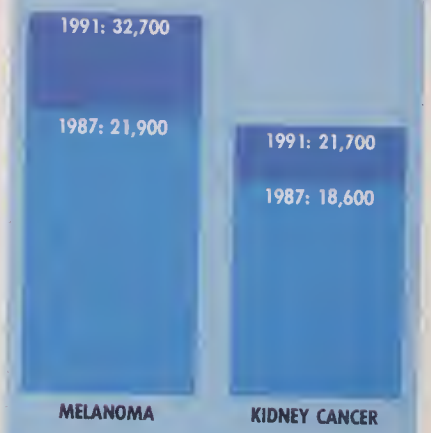
The past and present furor raised by IL-2 reports has two sources: the hope for a cancer cure and the anxiety of biotech investors. In the nine months before the October crash, the stock prices of Cetus and Immunex varied widely. Cetus stock ranged from $35⅝ to $11⅞; Immunex shares swung between $25⅝ and $9⅜ as investors struggled to make sense of conflicting reports on the progress of IL-2.

Stock swings for all public companies will continue. Investors have been excited by the prospect of biotech drugs knocking chemotherapy agents off the shelf, and IL-2's future as a combination therapy is more in line with the future of cancer therapy. At a recent conference on cancer diagnosis and therapy sponsored by Communitech Market Intelligence, company executives agreed that the current drugs will remain dominant through the end of the century as researchers struggle with biotech products and proportions.

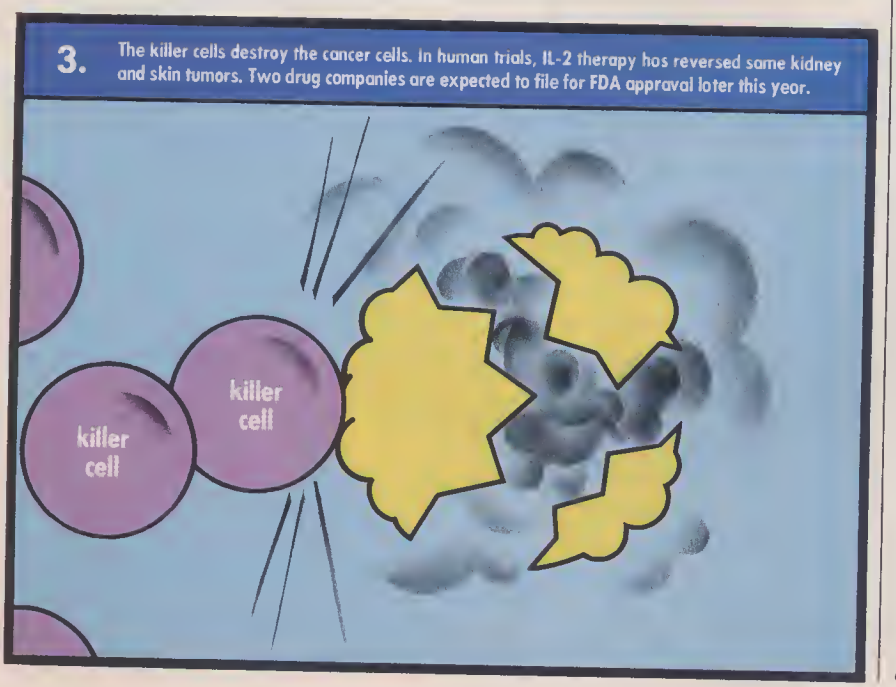
But strong-hearted investors would be wise to wait it out. The $275-million market forecast for IL-2 exceeds the revenues Erbamont N.V. received in 1987 on Adriamycin, the best-selling cancer drug in the United States. ■

THE RISING CANCER THREAT

IL-2 has been successful against melanoma and kidney cancer, two diseases whose incidence is expected to grow more rapidly than that of most other cancers. The following shows the estimated number of new cases in the next few years:



SOURCE: AMERICAN CANCER SOCIETY/EBERSTADT FLEMING



3. The killer cells destroy the cancer cells. In human trials, IL-2 therapy has reversed some kidney and skin tumors. Two drug companies are expected to file for FDA approval later this year.

LEADING 100

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE LAST QUARTER ($)	EARNINGS PER SHARE CHANGE FROM 1 YEAR AGO	LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
AEROSPACE									
Rohr Ind. (RHR/NYSE)	1/5	19.9	30.88	.49	206.3	—	17.8	.43	853.7
OEA (OEA/AMEX)	2/4	14.6	27.50	.36	.0	—	17.1	.00	42.2
Boeing (BA/NYSE)	3/7	14.3	55.88	.89	17.1	1.60	17.3	.05	15,205.0
Hexcel (HXL/NYSE)	4/11	14.2	33.50	.48	29.7	.44	16.6	.71	364.5
Rockwell Intl. (RDK/NYSE)	5/28	7.4	20.00	.81	26.6	.72	7.6	.23	11,804.4
Kaman (KAMNA/NASDAQ)	6/27	6.1	17.50	.37	19.4	.40	12.2	.55	728.6
Sequo (SQAB/NYSE)	7/17	6.0	70.50	NA	NA	.50	NA	NA	NA
ARX (ARX/NYSE)	8/3	5.9	9.00	.08	–66.7	—	11.7	.87	74.9
Sundstrond (SNS/NYSE)	9/9	5.5	55.50	.81	–11.0	1.80	31.7	.47	1,385.5
Sequa (SQAA/NYSE)	10/22	5.1	67.00	1.49	28.4	.60	15.7	.73	1,311.5
CHEMICALS									
Essex Chemical (ESX/NYSE)	1/67	72.0	30.75	.28	7.7	.52	NE	1.83	226.1
Am. Collaid (ACQL/NASDAQ)	2/40	34.2	25.50	.24	33.3	.79	17.5	.63	95.4
Ferro (FOE/NYSE)	3/3	22.0	37.50	.82	67.3	.68	14.3	.25	907.4
IMC Fertilizer (IFL/NYSE)	4/72	21.3	34.13	NA	NA	.37	NA	NA	NA
Hypanex (HYPX/NASDAQ)	5/11	20.3	11.13	.02	–95.1	—	NE	.88	121.4
Ausimont (AUS/NYSE)	6/15	19.1	33.50	.35	6.1	.60	18.6	.25	730.5
Immucor (BLUD/NASDAQ)	7/75	15.7	7.38	.07	133.3	—	30.7	.12	8.0
Combrex (CBAM/NASDAQ)	8/47	15.3	17.00	.38	–49.3	—	10.6	.09	111.0
Intl. Flov. Frag. (IFF/NYSE)	9/61	13.4	53.00	.95	30.1	1.60	17.4	.00	790.9
Flamemaster (FAME/NASDAQ)	10/1	13.3	4.25	.06	–14.3	—	15.7	.00	5.1
COMMUNICATIONS									
Optelecom (OPTC/DTC)	1/22	44.0	1.44	–.01	NC	—	NE	.00	3.5
Artel Comm. (AXXXX/NASDAQ)	2/61	28.6	2.25	–.24	NE	—	NE	.00	5.3
Intl. Telechrg. (ITI/AMEX)	3/59	22.2	11.00	.15	NE	—	91.7	.88	67.2
Centex Telem. (CNTX/NASDAQ)	4/24	21.5	12.00	.07	NE	—	NE	.01	41.5
US Cellular (USM/AMEX)	5/NC	18.1	18.75	NA	NA	—	NA	NA	NA
Cellular Comm. (COMM/NASDAQ)	6/58	16.3	28.50	–.21	NE	—	NE	2.70	41.6
Century Tel. (CTL/NYSE)	7/6	16.1	34.25	.43	13.2	.88	17.0	1.26	161.9
SW Bell (SBC/NYSE)	8/47	14.2	39.25	.73	–7.6	2.48	11.5	.63	8,125.7
Cinn. Bell (CSN/NYSE)	9/11	13.3	28.88	.64	28.0	1.12	13.4	.71	662.4
NW Telecom. (NDWT/NASDAQ)	10/12	12.7	31.00	.46	–30.3	.99	21.4	2.50	50.5
COMPUTERS									
Perceptronics (PERC/NASDAQ)	1/117	40.0	5.25	.10	11.1	—	NE	1.55	54.3
App. Data Camm. (ADCC/NASDAQ)	2/63	32.7	1.50	–.11	NE	—	NE	.00	7.0
Telematics (TMAX/NASDAQ)	3/15	32.4	12.25	.06	100.0	—	27.2	.00	46.4
Miltape Grp. (MILT/NASDAQ)	4/89	30.4	7.50	.03	–57.1	—	NE	.58	63.4
Paradyne (PDN/NYSE)	5/167	30.3	5.38	.01	NE	—	NM	.52	214.4
Data Meas. (DMCB/NASDAQ)	6/132	28.4	9.63	.08	–60.0	—	22.9	.03	11.6
Iomega (IOMG/NASDAQ)	7/175	28.1	3.69	.18	NE	—	NE	.13	102.9
Novell (NOVL/NASDAQ)	8/58	27.6	27.75	.20	25.0	—	33.8	.01	206.7
Key Tronic (KTCC/NASDAQ)	9/165	25.6	5.50	–.15	–100.0	—	28.9	.03	132.1
Britton Lee (BLII/NASDAQ)	10/65	23.5	2.63	–.01	NE	—	NE	.01	27.4
DRUG MANUFACTURERS									
Scherer RP (SCHC/NASDAQ)	1/44	45.1	24.50	.22	29.4	.36	23.6	.40	290.7
Newport Pharm. (NWPH/NASDAQ)	2/25	34.5	5.38	NC	NC	—	NE	.72	NC
Alca Hlth. (AAHS/NASDAQ)	3/3	30.5	26.75	.43	38.7	.12	16.6	.71	1,921.5
Xomo (XQMA/NASDAQ)	4/40	27.5	12.75	–.31	NE	—	NE	.64	8.8
Syntex (SYN/NYSE)	5/50	23.0	40.75	.62	19.2	1.30	16.9	.21	1,229.1
Forest Labs. (FRX/AMEX)	6/43	22.9	20.75	.27	22.7	—	21.6	.01	85.4
Synergen (SYGN/NASDAQ)	7/9	22.2	8.25	–.12	–100.0	—	NE	.12	6.2
Pharmacon. (PHAR/NASDAQ)	8/77	19.0	1.94	–.42	NE	—	NE	2.40	7.7
Alza (AZA/AMEX)	9/67	18.4	26.63	.12	33.3	—	59.2	.56	48.7
Upjohn (UPJ/NYSE)	10/55	17.6	32.63	.51	18.6	.72	19.1	.29	2,586.0

The HIGH TECHNOLOGY BUSINESS Leading 100 lists the 10 companies in each of 10 industries that had the highest stock gain over the previous month (figures as of 6/10/88).

NA = Not available NE = Negative earnings NC = Not calculable NM = No meaningful figure

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
ELECTRONICS									
Adage (ADGE/NASDAQ)	1/47	73.4	1.63	-.1B	NE	—	NE	.04	38.1
Alpha Ind. (AHA/AMEX)	2/75	69.5	7.00	-.37	NE	—	NE	.14	62.2
Semtech (SMN/AMEX)	3/115	63.9	5.13	.20	233.3	—	14.2	.44	17.1
Tech. Comm. (TCCO/NASDAQ)	4/155	52.2	B.75	.11	NE	—	NE	.00	2.6
Novar Elec. (NOVR/NASDAQ)	5/51	50.0	3.00	-.12	NE	—	NE	.01	15.9
Sun Electric (SE/NYSE)	6/60	45.7	16.75	.10	11.1	—	35.6	.47	200.3
Plasma Therm. (PTIS/OTC)	7/17	45.5	1.28	.01	NE	—	25.6	.42	21.5
SFE Tech. (SFEM/NASDAQ)	B/244	40.0	1.75	-.07	NE	—	NE	.B3	3B.5
Tech-Sym (TSY/NYSE)	9/157	39.B	17.13	.31	3.3	—	13.6	.17	115.9
Adv. Circuits (AOVC/NASDAQ)	10/240	37.0	4.63	.07	600.0	—	NM	.5B	77.5
HEALTH									
Collagen (CGEN/NASDAQ)	1/9B	37.8	6.3B	-.0B	-100.0	—	NE	.01	26.1
Meridian Diag. (KITS/NASDAQ)	2/1	32.3	4.63	.01	-50.0	—	51.4	.04	5.3
Biosearch Med. (BMPI/NASDAQ)	3/2	25.3	1.88	.09	NE	—	NE	17.60	18.7
MOT (MDTC/NASDAQ)	4/16	24.1	13.50	.26	225.0	—	18.0	.00	70.4
Everest & Jen. (EJB/AMEX)	5/8	22.4	15.00	.0B	NE	.10	NE	.63	183.3
Damon (OMN/NYSE)	6/102	21.7	28.00	.14	100.0	.20	59.6	.33	195.2
Lumex (LUM/AMEX)	7/99	21.5	12.00	-.04	-100.0	.08	NE	.26	76.0
Dento. Med. (OTMD/NASDAQ)	B/114	21.0	1.44	-.02	NE	—	NE	.00	.1
Thermedics (TMO/AMEX)	9/107	17.6	10.00	.01	.0	—	NM	1.00	21.4
Newport (NEWP/NASDAQ)	10/33	17.3	15.25	.23	91.7	.12	21.2	.00	51.3
METALS FABRICATION									
Synalloy (SYO/AMEX)	1/7	19.9	5.25	.20	400.0	—	27.6	.17	54.9
Schwob Safe. (SS/AMEX)	2/32	19.0	17.25	.35	-16.7	.56	12.1	.00	14.0
Elco Ind. (ELCN/NASDAQ)	3/18	18.0	36.00	.97	29.3	.B8	11.7	.44	137.3
ABS Ind. (ABSI/NASDAQ)	4/44	15.0	11.50	.15	-58.3	.B0	41.1	1.66	20.8
Columbia Gen. (CLGN/OTC)	5/3	12.5	6.75	.15	-44.4	—	3.5	.42	54.1
RB&W (RBW/AMEX)	6/5	12.1	5.75	.15	650.0	—	NE	.90	175.9
Allegheny Lud. (ALS/NYSE)	7/6	11.3	29.63	.90	21.6	.4B	12.2	.40	935.5
Moog (MOGA/AMEX)	B/43	10.B	11.63	.05	-B3.3	.28	10.1	.94	306.9
Vorlen (VRLN/NASDAQ)	9/21	10.7	19.75	.13	NE	.57	13.6	.B1	169.9
Fla. Steel (FLS/NYSE)	10/11	10.0	3B.63	.92	50.8	1.00	13.6	.61	437.8
SCIENTIFIC AND ELECTRONIC INSTRUMENTS									
Monitor Tech. (MLAB/NASDAQ)	1/13	50.0	4.50	.18	B0.0	—	11.0	.00	10.3
Brajdas (BRJS/NASDAQ)	2/37	3B.7	7.63	.32	700.0	—	11.9	1.14	47.5
Bowmar Inst. (BOM/AMEX)	3/94	3B.0	1.38	-.17	NC	—	NE	1.78	3B.1
Esterline (ESL/NYSE)	4/67	32.6	15.75	.36	414.3	—	NE	.35	281.7
Buehler Intl. (BULR/NASDAQ)	5/93	30.0	9.75	.17	30.8	.28	13.0	.05	70.0
Wash. Scien. (WSCI/NASDAQ)	6/30	28.0	B.00	.0B	-3B.5	.15	12.1	.41	34.B
Ariz. Inst. (AZIC/NASDAQ)	7/70	27.1	4.13	.01	-75.0	—	20.6	.17	9.3
Impact Sys. (MPAC/NASDAQ)	B/64	27.1	4.13	.07	133.3	—	15.3	.09	30.3
Kulicke & Soffa (KLIC/NASDAQ)	9/59	22.4	11.63	.03	NE	—	NE	1.00	71.1
Laser Photo (LAZR/OTC)	10/1	21.7	2.13	-.4B	NE	—	NE	1.45	4.9
SOFTWARE AND DATA PROCESSING									
AGS Comp. (AGS/NYSE)	1/15	46.6	27.13	.39	39.3	—	20.9	.44	533.3
Computrac (LLB/AMEX)	2/60	35.3	5.25	.06	100.0	.07	NE	.11	6.B
Soft. Pub. (SPCO/NASDAQ)	3/72	29.9	20.63	.37	76.2	—	20.2	.00	4B.2
Corp. Soft. (CSOF/NASDAQ)	4/52	26.1	14.50	.1B	100.0	—	22.7	.05	68.5
System Soft. (SSAX/NASDAQ)	5/10B	25.0	17.50	.20	42.9	—	22.7	.01	43.2
Ooisy Sys. (OAZY/NASDAQ)	6/7	20.3	11.13	.07	NE	—	NE	.00	10B.3
AutoInfo (AUTO/NASDAQ)	7/128	19.8	3.75	-.05	NE	—	NE	.00	2.B
Mentor Graphics (MENT/NASDAQ)	B/9	19.0	34.50	.40	60.0	—	25.6	.00	238.9
Natl. Bus. Sys. (NBSIF/NASDAQ)	9/140	19.0	2.38	-.19	NE	—	2.9	.78	1B9.6
Digilog (DILO/NASDAQ)	10/27	1B.B	5.50	.01	-93.8	—	16.7	.01	15.3

SOURCE: MEDIA GENERAL FINANCIAL SERVICES

Accounting for Automation

Updating traditional methods should help companies justify technology purchases

BY SAL NUCCIO

ANDREA BARUFFI

IT'S A common scenario in U.S. manufacturing: A company's engineers argue that they need high-tech factory equipment in order to compete with foreign competitors. But the accountants who must approve such purchases say the cost of the equipment is too high, and the expected payback too low, to justify the expense.

Cost-accounting practices haven't kept up with the realities of modern manufacturing. Traditional cost management determines a product's cost largely according to the amount of labor that goes into it. But today other production costs, mainly for automation, are more important. To compete in the international marketplace, where high quality, low cost, and product flexibility are paramount, manufacturers must invest in machines and systems that don't always add up to a direct, bottom-line payoff.

To address this issue, a group of 40 companies is sponsoring a project aimed at developing new guidelines for determining the costs of products. The Cost Management System (CMS) project is being conducted by Computer Aided Manufacturing-International Inc. (CAM-I) of Arlington, Tex., a nonprofit research consortium. Better accounting methods will help companies make better investment decisions, and also could lead to increased spending on advanced automation equipment, because companies will have a more reliable way to figure out whether such investments are worthwhile.

Traditional cost accounting typically computes a product's cost according to the amount of labor performed on it, plus the cost of the product's materials, plus a portion of a catch-all called overhead, which accounts for the price of machinery and facilities. However, this method generally does not let management accurately determine if existing or proposed manufacturing equipment is really needed. "We must look at other things, such as the ability to move to other product lines, to work as part of a team, or to maintain a high level of operational flexibility," points out Tom Sternad, a controller in the Beckman Instruments division of CMS sponsor SmithKline Beckman, the pharmaceutical company.

For example, under the traditional method, the overhead cost for a particularly expensive piece of factory equipment may be charged against all products made in the plant—even if the expensive machine is used for only one of the factory's products. That may cause a company to understate the product's cost, or to overstate the cost of goods that aren't made using the expensive equipment.

Robert D. Moravec, senior business consultant with Xerox Computer Services in Los Angeles, remembers a former employer that invested $100,000 in

ANOTHER CRACK AT THE NUMBERS

An impressive marshalling of industry and academic forces is trying to update cost-management practices to address today's manufacturing environment, which often includes advanced technology.

A consortium called Computer Aided Manufacturing-International (CAM-I), formed in 1972, is conducting the Cost Management System (CMS) project. The project's sponsors include such CAM-I members as Boeing, General Dynamics, General Electric, Johnson Controls, Lockheed, Martin Marietta, Rockwell International, Westinghouse, and Xerox. The U.S. Air Force and Navy are also participants. Each sponsor pays $15,000 per year, on top of CAM-I's annual membership fee of $12,000.

CMS is also sponsored by six of the Big Eight accounting firms: Arthur Andersen, Coopers & Lybrand, Deloitte Haskins and Sells, Ernst & Whinney, Peat Marwick Main, and Price Waterhouse. "We want to help our clients and get a better understanding of their issues and problems," says Richard B. Troxel, a partner at Peat Marwick Main & Co. in Chicago and chairman of the project.

The CMS project is in its final phase. Cost-accounting principles developed in 1987 are being tested at about 10 sponsor companies. During this process, principles may be modified to account for problems overlooked earlier.

"After the concepts are validated this year, their implementation will accelerate," predicts project director Tom Pryor. Many sponsors have their own implementation programs, and must reconcile the new concepts with their established cost-accounting procedures.

CAM-I plans to promote changes in accounting practices by spreading the word about project findings. The consortium will ask academia to include CMS concepts in its classes and research, and plans to present findings at conferences. CAM-I also hopes to meet with legislative and regulatory groups to preach the importance of cost-management systems to industry and the national economy.

an automated welding system—"a big investment for a $10-million company," he says. However, the labor savings were not high enough to offset the additional cost of depreciation, operation, and programming.

"The shop's welding costs more than doubled," recalls Moravec. But instead of assessing the high costs only to products that passed through its welding shop, the company figured the new costs into all of its products. "That baseless decision caused pricing problems that long affected marketing plans and strategies," he says.

Remedies proposed by the CMS project include ways to factor in costs that stem from equipment depreciation, maintenance, and software. Software often proves more expensive than manufacturing hardware and requires accelerated depreciation timetables to account for its often short lifespan. The project also suggests ways to account for the costs and benefits of improvements in quality, a major selling point of high-tech automation.

In addition, the project encourages accountants to consider the intangible benefits of high-tech equipment, such as the flexibility to put a new product into production more quickly, or to change existing products. "Cost-accounting systems don't show management the benefits of flexibility," says Tom Pryor, director of the CMS project.

"We're attempting to shift the focus from control to planning," says Pryor. "Traditional cost accounting provides conservative control, with emphasis on quick payback on investments. Modern cost management encourages more planning."

The CMS project offers not so much a programmed alternative as a change in approach and attitudes, so it's hard to assess what impact it will have. The expectations of many sponsors seem modest. Thomas M. O'Brien, manager of production management programs for General Electric, says his company is after new ideas, the best practices, successful practitioners, and pertinent educational and communications materials. "CAM-I has been extremely helpful in spreading the word on the need for improved cost-management systems," says O'Brien.

Of course, many see the spread of updated cost-accounting as a real, if intangible, benefit. "Rockwell would be a beneficiary of the spread of the gospel of cost management to government, to other manufacturers, and especially to major accounting firms, which then would propagate the concepts among their corporate clients," says Jack Schuber, director of cost-accounting development at Rockwell International.

Suppliers of advanced automation equipment may have the most to gain from updated cost-accounting procedures—not just by improving their own operations, but also by giving customers more justification for investing in high-tech equipment.

"Companies that adopt CMS would better understand what our systems could do for them, and that would increase sales," says Jim Seghers of the corporate controller's staff at Johnson Controls of Milwaukee, a supplier of factory machinery and energy control systems for buildings. Of course, it's impossible to estimate how much automation spending may increase—for one thing, he says, that depends on how broadly the CMS philosophy is adopted. But manufacturing suppliers have long blamed antiquated cost-accounting rules for lost sales. "Our Allen-Bradley division would find it easier to sell its automated manufacturing controls [with CMS]," says Rockwell's Schuber.

Many people agree that cost-management needs reform. The question, however, is whether or not the CMS project will stimulate substantial change.

Some critics say no. "A lot of people are interested in the cost-management area, but it appears as if the search has not revealed the answer," says William Ferrara, professor of accounting at Pennsylvania State University.

On the other hand, the clamor for updated cost accounting is intensifying. Outmoded methods are considered one of the main barriers to advanced automation. Thus, the impetus to change is growing stronger, expecially as companies feel the tightening squeeze of foreign competition. ■

Sal Nuccio is a business writer and consultant in New York.

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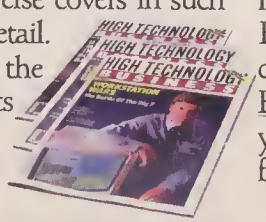

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Full-service suppliers also offer far more liberal credit arrangements, and

JULIE HOUCK

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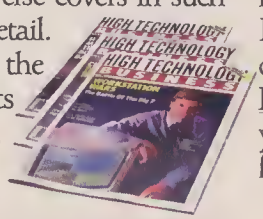

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Connecting

BY RANDY ROSS

JULIE HOUCK

Telephone technology helps DeBlois Oil save money and serve customers more efficiently

RED LIGHTS cluster on the phone-system monitor like flies on a screen door. As they swarm, switchboard operator Patricia Provost dispatches each call with a blur of fingers on her keyboard. In the lower right-hand corner of her screen, however, one group of lights flickers unnoticed. Provost doesn't know that these lights, which represent rented long-distance "tie" lines, make her life easier. But she admits that since her employer, DeBlois Oil, installed its new telecommunications system two years ago, "the phones haven't gotten any crazier." Tie lines connect, or tie together, two telephone systems at separate locations, in effect creating a single system.

Like many of the best technology applications, the new telecommunications system at DeBlois Oil Company of Pawtucket, R.I., and its associated tie lines, is relatively transparent to the employees who use it. But the system has made a clear impact on the company's bottom line. Arthur DeBlois III, vice president of finance, estimates that since installation, the tie lines have cut overall phone costs by about $10,000 per year or 9 percent, while the company has grown 15 percent. At that rate, the system should pay for itself in about six years. More important, the system improves customer service, a key to survival in the mature and crowded New England home-heating-oil market.

DeBlois Oil bought its new phone system and switched to tie lines to maintain an economical presence in local communities while consolidating administrative functions in its headquarters. Historically, large heating-oil companies operating in New England have faltered when they begin to treat customers impersonally, says Charles Burkhardt, former chief executive officer of the New England Fuel Institute. About 250 competing oil distributors work DeBlois Oil's Rhode Island market.

The home-heating-oil business is not a high-tech industry, and traditionally has consisted of small operations with close ties to the community. Full-service fuel companies charge almost 30 percent more for their oil than do discount operations. The only way to justify that kind of premium is personal attention. Customers know that if their heat fails, a repairman will hop a snowmobile or swim through a flooded basement to fire up their boiler. Customers can buy their oil from "Zeke the Discounter" and save $.20 per gallon, but Zeke may or may not answer an emergency call at three in the morning.

Full-service suppliers also offer far more liberal credit arrangements, and

an extra level of service that can save a bundle if it keeps water pipes from freezing, cracking, and later causing thousands of dollars worth of damage to a customer's home or business.

Personal service is the key to DeBlois Oil's success. The $65-million diversified petroleum company gets about 35 percent of its revenues from home-heating oil and dominates Rhode Island with a 10 percent market share, more than three times as much as its closest competitor. DeBlois Oil grew through aggressive marketing and by acquiring dozens of smaller outfits over the last 40 years. But the company's continuous growth created a dilemma: how to provide prompt, personal service to customers throughout the state while taking advantage of economies of scale by consolidating as many aspects of the operation as possible.

Ironically, DeBlois Oil uses centralized technology to maintain its local presence and personal touch. The company provides most of its customer services, including fuel delivery, maintenance, and repairs, from four divisional offices. Credit and bookkeeping get handled at headquarters. The trick is making customers feel as if they're dealing with a local office, even when headquarters gets involved.

In the past, DeBlois Oil used "foreign-exchange" lines to transfer all calls destined for outlying offices to headquarters automatically. Such lines allow access to an exchange (the first three digits in a phone number) in another, "foreign" area; customers dialed a local number and were connected directly to the service operator at headquarters. They paid only for a local call and usually had no idea they were talking to someone across the state.

But as the company grew, this telephone system became increasingly inefficient and costly. Because all calls were routed to headquarters, the lone operator there was deluged, and requests for repairs or oil delivery had to be transferred back to the outlying divisional office. Tie lines were not an option, because parts of the Rhode Island phone system could not handle them. Meanwhile, the cost of the foreign-exchange lines was climbing. "Our [overall] phone bills were increasing about 20 percent a year," recalls DeBlois.

As the bills rose, service deteriorated. The overloaded main operator sometimes couldn't get to a call for nine or ten rings, frustrating customers. Transferred calls were often cut off, unanswered, or hard to hear. "You thought customers were whispering when they may have been screaming," recalls Douglas Foster, vice president in charge of divisional operations. Unintelligible conversations led to inefficiency; in some cases, delivery trucks were sent to the wrong address.

Nelson Communications, a Boston telecommunications consulting firm, helped design a solution. Improvements in New England Telephone's service had made tie lines available throughout the state, and hardware prices had fallen as suppliers battled for market share after the AT&T breakup.

DeBlois Oil replaced its overtaxed Executone D1000 phone system and Equity 1A2 electro-mechanical key systems with an electronic system from Mitel Corp. The new system consists of an SX-200 private-branch exchange (PBX) and two SX-10 key systems equipped to handle tie lines. Tie lines, rented from New England Telephone, provide a direct long-distance connection between the divisions and the main office. The price: $58,100 for the Mitel equipment and tie-line installation.

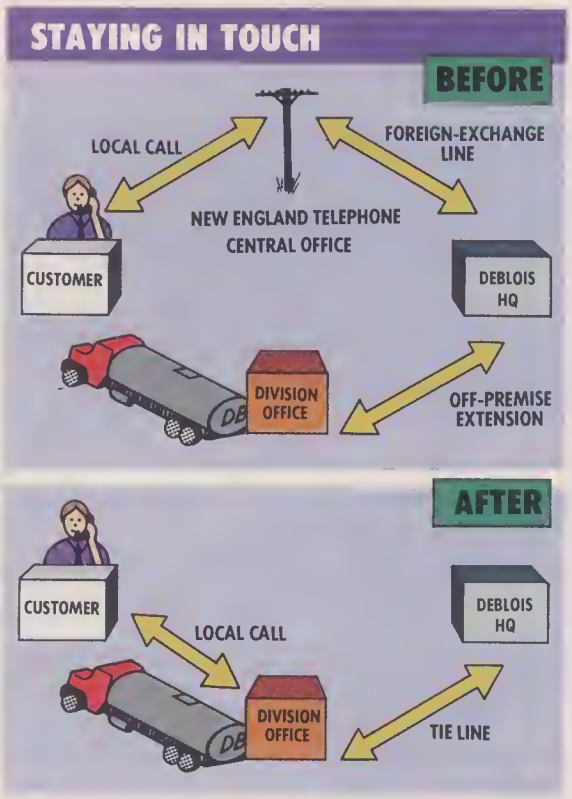
This modest new system has made a big difference to DeBlois Oil. Now, customers call the local office first, where most problems get handled on the spot. "With the foreign-exchange lines, about 60 percent of the calls to the main office were sent back to the division," says DeBlois. When a billing or administrative situation requires input from headquarters, the local operator simply transfers the call; customers never know they are venturing across the state. With less long-distance calling, the company was able to replace eight foreign-exchange lines and their associated off-premise extensions—used to transfer calls back to the divisional office—with just four tie lines, DeBlois says.

The new system is cheaper even when long-distance transfers are necessary. The tie lines each rent for about $300 a month; foreign-exchange lines and their associated off-premise extension cost $500 to $600 per month.

The effects of the system, which was up and running by early 1986, were dramatic. "Clarity improved 100 percent, we had less transferring, and the timeliness of our responses [to customer inquiries] improved," says DeBlois. Less transferring results in happier customers. In addition, the new system also lets employees work more efficiently by giving them better access to information from the main office. When employees work more efficiently, DeBlois Oil customers benefit because questions and problems get resolved faster, says Foster.

The system also has improved morale and overall performance. The old phone system had become an excuse for employees not doing their job. Now, the line, "Gee, I didn't hear anything" no longer works.

DeBlois Oil is considering expanding into the even more competitive Boston fuel-oil market, and savings from the new phone system will provide the cash to fund such a venture. Taking risks with technologies has let DeBlois Oil better serve its customers and polish its reputation. "DeBlois is the most computerized outfit I've ever [seen]," says Burkhardt. "They operate with ruthless efficiency." ■



KAREN KARLSSON

Newsletter Digest

Excerpts and expertise from newsletters covering the latest technological developments.

SEMICONDUCTORS

SEMICONDUCTOR ECONOMICS REPORT

Will Flash Memories Replace Today's Memory Chips? Intel Corporation has announced the availability of 64- and 256-kilobit, non-volatile, read/write flash memories. These devices are in-circuit electrically bulk-erasable circuits that fill the gap between EEPROMs and UV-erasable EPROMs.

Initially, the ideal applications are for automotive and industrial embedded control systems that require on-line programming or routine updating. This new approach is expected eventually to capture a large percentage of the programmable-memory market because of the relative ease and cost of reprogramming and the potential initial low cost.

The key question is, will the potential low cost of this new memory process affect future applications of DRAMs, the conventional memory chip?

A flash memory cell has the same basic processing steps as a typical EPROM device. NMOS devices are processed on a P-type substrate using self-aligned masking techniques. Two levels of poly silicon form the control and floating gate. The major difference in the flash-memory cell is that the oxide thickness under the floating gate is reduced to allow edge-effect electron tunneling for programming and bulk erasure. The result is the same functionality and byte programming as that provided by EPROMs, but with electronic bulk-erasing capabilities.

The flash memory is designed with common source connections. The cells are programmed by placing the programming voltage (typically 12 volts) on the control gate and drain. This generates "hot" electrons which are swept across the channel. The high-control gate voltage attracts these free electrons across the thin lower gate oxide into the floating gate, where they are trapped. Note that this same mechanism (Fowler-Nordheirm tunneling) is also considered to be a major reliability problem for submicron MOS transistor designs. Thus, Intel is currently guaranteeing only 100 erase/program cycles. A 10,000-cycle version is expected to be available in the fourth quarter.

The key factor, however, is the potential low cost. The layout is extremely simple, and dense. Since no planar or trench capacitors are needed (all the information is stored on the floating gate), only the equivalent area of an NMOS transistor is required per bit. Therefore, the design is completely scalable down to any submicron level. With the current design approaches, and for the same processing resolution, the flash memory cell can be half the size of a DRAM cell.

Thus, in theory, with the equivalent volume production, and learning, the flash memory could sell for half the cost per bit of DRAMs. However, with the programming and logic "overheads," only about 35 to 40 percent of the flash-memory chip area consists of memory cells, compared to 50 percent for DRAMs. For example, the chip area of a 256K flash memory is 36,740 sq. mils as compared to 45,000 sq. mils for a 256K DRAM. Without the extra overhead, this chip could be as small as 25,000 sq. mils.

This will eventually be a major new product for embedded-controllers in the automotive and industrial markets. However, a complete change in the current computer architecture would be required for massive use of this type of memory.

CONTENTS

Flash Memories Use Hot Electrons

Historically, the semiconductor industry has been able to turn a failure mechanism into a product. The classical example is the problem of inversion/channeling on early bipolar devices, which, when controlled, becomes an NMOS transistor. The industry is doing it again with "hot" electrons and tunneling. One new product, flash memory, uses these two potential failure mechanisms for fast programming and erasure.

Hot electrons are a result of the industry's push to submicron geometries. These carriers are those electrons and holes in the channel and pinch-off regions of an MOS transistor that have gained so much energy from the lateral electric field produced by the source-drain voltage that they will impact other atoms and create more carriers—a multiplying effect.

If enough energy is gained, these electrons will be able to jump the barrier into the gate oxide and create a shift in gate threshold voltage. Or, if the poly gate material is positively biased, these hot electrons will tunnel completely through the oxide to the gate, or be trapped as a bias charge on a floating gate. Tunneling occurs when the voltage across the gate oxide exceeds 5 million volts per centimeter (or 5 volts per 100 A of oxide thickness). Tunneling, therefore, is not catastrophic, as long as the transient currents are held below a density of 0.1 amp per sq. centimeter.

When controlled, the designer is able to use these effects repeatedly for circuit function. However, there are still long-term degrading and "wear out" effects, which still limit the total number of times tunneling and hot carrier injection can be applied.

SUPERCONDUCTIVITY

The Cambridge Report on SUPERCONDUCTIVITY

MIT Finds New Use for Superconductivity

A research group at the Massachusetts Institute of Technology has come up with a totally new application area for high-temperature superconductivity (HTSC). Daniel R. Cohn, division head in the Plasma Fusion Center at MIT, has evidence that important commercial applications may exist for HTSC materials in millimeter/submillimeter radar, communications, satellites, television, lasers, and related fields.

Cohn heads a group that has been investigating the use of HTSC materials as a coating inside super-high-frequency generators, resonators, waveguides, cavities, etc.

The significance of the MIT work lies in using the HTSC coating to increase efficiency and bring the applications of super-high frequencies closer to commercial reality. Millimeter/submillimeter waves can make possible radar systems with essentially photographic precision and resolution.

Major uses would exist in millimeter-wave communications and in television, with wide bandwidth and high sensitivity. These would make possible satellite systems requiring only the smallest antennas (dishes) in the range of a few inches in diameter. Other potential applications exist in particle accelerators, lasers, surveillance satellites, and radio astronomy.

Fundamentally, millimeter waves could extend significantly the available radio (electromagnetic) frequency spectrum. At present, most of the world uses frequencies from 50 to 30 GHz for "wireless" applications. These include radio (both AM and FM), communication satellites, television, radar, radio astronomy, and position location and finding.

The existing spectrum (up to 30 GHz) is badly overcrowded with users; groups constantly battle each other for available channels. The MIT work suggests future operation to 5,000 GHz—an extension of the available spectrum by a factor of 167 times the present electromagnetic "space." This would be an expansion of more than two orders of magnitude.

Television that uses many times the width of the present spectrum-limited channels would have true photographic quality. Airborne or satellite millimeter/submillimeter radar could be used to survey and map land areas with better precision than existing land-surveyors and with less sensitivity to weather than laser systems. These and many other applications are logical consequences of practical millimeter/submillimeter-wave equipment.

Until now, these areas have been the subject of practical large-scale exploitation because of the

relative inefficiency of low-temperature metal-alloy superconductors and the technical problems in the use of the known best materials, such as copper.

Cohn and his colleagues believe that the wide "energy gap," a basic physical property inherent in the ceramic-oxide superconductor, will uniquely open the doors to HTSC for practical applications.

Basically, super-high frequency (submicrowave) components become smaller and smaller as wavelength decreases. Most radars, TV satellites, etc., operate at microwave frequencies in which the waves they emit or receive are centimeters long. Until recently, this was considered small—*micro*wave. A centimeter is huge compared with submillimeter wavelengths.

As an example of the size issue, a typical conduit (waveguide) that conducts radar signals is a hollow rectangular or circular copper pipe with interior dimensions in centimeters. At a one-millimeter wavelength (300 GHz), interior dimensions are only 0.825×0.405 millimeters. The surface area of the waveguide's interior walls becomes larger and larger, compared with the volume, as the open space within the volume becomes smaller and smaller. Copper or silver, which are excellent for ordinary microwave applications, have too much energy loss for practical applications in millimeter-wave equipment because of the problems outlined above. These losses could be avoided by making the waveguide cross-sections much larger (many wavelengths).

The electrical losses, or the complication in submicrowave applications up to now, have been severe and seem to have limited most practical applications.

Superconducting cavity and waveguide interior walls have been used to keep microwave-equipment efficiency within practical limits. Low-temperature superconductors such as the niobium metal alloys have been employed to decrease power loss in conventional microwave oscillators, filters, particle accelerators, and other applications. However, the small "energy gap" in the LTSC materials, as well as their lower tolerance for large electric and magnetic fields, limits their usefulness in millimeter-wave equipment.

Cohn and his colleagues have written a paper, "Possible High-Frequency Cavity and Waveguide Applications of High-Temperature Superconductors," which is scheduled for publication in the *International Journal of Infrared and Millimeter Waves.* The paper analyzes the advantages of HTSC ceramic materials (which have a much wider energy gap and a tolerance for higher fields) and suggests a limit of approximately 5,000 GHz: 5 TeraHertz (THz) for the present HTSC compounds. This is a wavelength of 0.06 millimeters—2.5 thousandths of an inch—the diameter of a human hair. (At one THz, the wavelength is 0.3 millimeters.)

The paper also presents cooling methods, such as passing cold helium gas through waveguides, resonators, etc., both to reach the necessary low temperatures and to provide increased power-handling capacity (because helium is superior to other gases for such purposes). Of course, in satellites, cooling is unnecessary, since outer space is inherently cold.

Among other criteria the group explored, they found that the HTSC films coating the interiors of components do not require electrical contacts or special structural support. However, they must be continuous and they must not have uncoated areas.

Cohn's research makes it clear that the application of HTSC materials to millimeter/submillimeter communications is unique; while other materials and designs can be employed, the HTSC material seems to have unique properties and advantages.

According to Cohn, the MIT group is open to proposals for funding and support from other government and industrial sponsors.

AEROSPACE

SATELLITE WEEK

Tests Prove Mobile Satellites Work

A series of tests has shown the technical feasibility of mobile satellite service (MSS) for land and aeronautical transmission of both voice and data, according to papers presented recently at the MSS conference in Pasadena, Calif. The conference, sponsored by NASA's Jet Propulsion Lab, was attended by about 400 persons from America, Europe, Asia, and Australia.

Omninet is scheduled to begin the first fully

operational MSS service using GTE's GStar Ku-band satellite next week. Technically, it's a radio-determination satellite service (RDSS) intended for position location, but is expected to be used mainly to send alphanumeric messages between trucks and home bases.

The first preoperational aeronautical mobile satellite service (AMSS) began May 1 when Canada upgraded a system installed on an air ambulance from experimental to preoperational, according to John Butterworth of Communications Canada. Preoperational status means it will be used on actual ambulance flights. Communications Canada began flight testing the system using the Inmarsat Atlantic Ocean Region satellite November 24, 1987, and found communications quality to be at least adequate, Butterworth said in a paper.

The unit is to be used for voice communications to relay instructions from ground-based doctors to on-board paramedics. Butterworth said communications were "reliable," but there should be improvements. The first priority, he said, is to replace window-mounted antennas with externally mounted, steerable antenna.

British Airways was to have begun AMSS trials on a commercial Boeing 747-200 in late July, James Schoenenberger of equipment-manufacturer Racal told us. Tests had been scheduled to start in March, but were delayed because necessary ground equipment hadn't been installed in time, he said. British Airways will install the unit, which also uses Inmarsat capacity, on a second aircraft in November. For the first two weeks, equipment will be used only for tests, Schoenenberger said, but by August passengers will be able to charge satellite telephone calls to credit cards while flying over the Atlantic. The system should be fully operational worldwide, using earth stations in Norway, Singapore, and the U.K., by mid-1989, he said.

Japan's NEC will begin testing a mobile earth station capable of converting analog voice to digital codes at data rates of 9.6, 8, and 4.8 Kbps in the near future, said Ryutaro Suzuki of Japan's Communications Research Lab. This system will communicate via Japan's ETS-5 satellite.

The results of propagation tests for land mobile services were acceptable, but not excellent, officials said. Rockwell International tests, for example, showed that messages moved from satellite to a mobile vehicle 92.4 percent of the time, and from vehicle to satellite 75.4 percent of the time, according to a paper. Hughes Aircraft showed a video of a test of its MobileStar system at various data rates. The tape indicated that voice communications broke up repeatedly when buildings or trees intervened between the unit and a simulated satellite. Despite problems, speakers said, the tests showed at least adequate results for this period of development.

Telesat Canada will begin testing a two-way data messaging service this summer and fall, according to David Sward, the firm's manager of business development. Full commercial service is to begin in late 1989. The system, called Fleet-Star, will use Inmarsat capacity to accommodate up to 6,000 vehicles, Sward said.

JPL will begin a second series of tests of mobile satellite technology this summer in Hawaii, said JPL's Jeff Berner. Tests using the Inmarsat Pacific Ocean satellite will evaluate a Ball Aerospace earth terminal with a phased array antenna. Initial tests using Teledyne-Ryan equipment showed the equipment was "appropriate," Berner said.

Achieving global cooperation on MSS is the next major hurdle for industry, according to officials speaking at the conference. A lack of international agreement "poses a severe risk to the integrity and viability of all services," said Jerry Freibaum, an industry consultant and former NASA official. Mechanisms exist within the FCC and the International Frequency Registration Board (IFRB) to resolve disputes, he said, but those processes take years, and the delay could increase costs so much that the market wouldn't accept MSS.

The problem is that everyone wants an entire spectrum allocated for MSS, Inmarsat Director General Olof Lundberg told attendees. In the United States alone, both AvSat and AMSC want an entire 14 MHz. The same spectrum is used by Inmarsat and the Soviet Union, and is sought by already announced systems from Australia, Canada, the European Space Agency, and even Papua, New Guinea. More systems are likely in places such as Brazil and India, said Lundberg.

AMSC and AvSat believe they need 14 MHz to be viable. Officials wouldn't comment on whether the fact that they almost certainly will have to share spectrum will affect economic viability. One possibility, Freibaum said, is seeking additional spectrum at the proposed 1992 Mobile World Administrative Radio Conference. "I see L-band as a battleground," he said. "Getting extra spectrum

won't be easy. We will have to start doing our homework now."

The FCC and IFRB will step in if industry can't reach an agreement on its own, but the result will be "missed business opportunities and increased cost," according to Brian Fontes, special assistant to FCC Commissioner Quello. "If you resolve all your differences before you come to the FCC, you'll save everyone an incredible amount of time," Fontes said. "If you don't work out your disagreements, you can price yourself out of the market."

Even the FCC and the International Telecommunication Union (ITU) disagree on spectrum allocations for MSS. The disagreement gives AvSat and AMSC "good arguments" to take to the FCC, Freibaum said, so whichever loses almost certainly will appeal to the commission, "which gets us right back into the delay cycle."

"All of these systems can't co-exist as they're originally proposed," Lundberg said. "The end result will be severe limits." Even geographic spacing won't be enough, he said, because omnidirectional MSS antennas illuminate the entire visible arc, and even high-gain antennas would require about 50 degrees spacing. MSS providers have to begin talking soon about ways to coordinate activities before they start placing equipment orders for service to begin in the early 1990s, officials said.

There's no formal forum for international coordination discussions that would head off lengthy FCC or IFRB processes, an airline MSS official said. The only solution, he said, is an informal process of monitoring competitors' developments and trying to adjust one's own plans to accommodate them. AvSat, for example, "deliberately avoided" the 3 MHz now being used by Inmarsat, he said. However, they couldn't avoid the 14 MHz applied for by the Soviet Union.

Problems and opportunities extend beyond frequency sharing. Equipment cost decreases sharply with the size of production runs; thus, officials would like to develop common standards so the same equipment can be sold around the world. Consumers also would like interoperability, which would allow the same satellite receivers to function anywhere and permit interconnections among maritime, land, and aeronautical mobile systems. MSS providers also need to cooperate just to develop an overall market, Lundberg said.

The formation of AMSC means that a U.S. land mobile satellite entity exists with which to coordinate. AMSC officials, however, wouldn't comment immediately on calls for increased cooperation. Their reply will be included in comments they must file on a proposal to allow Inmarsat to provide land mobile service, they said.

MSS officials should be concerned about possibly losing both spectrum and market to the cellular industry, Lundberg said. "I believe the mobile market will explode," he said. "The question is the size of the market that will be served by satellites." He said U.S. and European cellular industries plan to set up cells along major long-distance highways, which could usurp much of the long-haul trucking business MSS is counting on. The cellular industry also is likely to seek additional spectrum.

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militarySPACE

ALS Engines to Be Simple, Cheap

Propulsion for the heavy-lift Advanced Launch System (ALS) may take a technological step backward to lower U.S. space-launch costs.

In the past, U.S. rocket engines were designed for high performance and low weight, with little attention paid to operating costs. But meeting the ALS program's goal of a ten-fold reduction in launch costs forces engine makers to adopt the Shaker philosophy, "'Tis a gift to be simple."

The shift in design philosophy can be best seen in the liquid oxygen/liquid hydrogen (LOX/LH_2) engines for the ALS core vehicle. The joint NASA-Air Force program has made a low-cost LOX/LH_2 engine its highest technical priority. This engine could be used to boost 150,000-pound ALS payloads in the 21st century; propulsion technology could also be "spun-off" for use on advanced versions of smaller expendable Titan, Delta, and Atlas launchers.

In the 1970s, NASA's Marshall Space Flight Center and Rockwell's Rocketdyne division developed a space-shuttle main engine (SSME). This reusable, throttleable engine used a staged combustion cycle and high-performance pumps to drive fuel into an ultra-high-pressure (3,200 pounds per sq. inch) combustion chamber. Each SSME can create 470,000 pounds of thrust in a vacuum; each

costs $30 million.

Fifteen years later, Marshall and ALS engine designers want an expendable, $3 million to $5 million LOX/$LH_2$ engine with 300,000 to 600,000 pounds of thrust. To achieve this goal, ALS engines will probably use a lower-pressure (2,000 psi) combustion chamber and a gas generator to drive fuel pumps.

The gas generator cycle was perfected in the 1960s for the J-2 engines on Saturn V moon rockets. Rockwell's space transportation division is now including an improved "J-2S" in its ALS vehicle design. The contrast between the SSME's "Indy racer" motor and the ALS's "pickup truck" engine extends beyond performance, ALS propulsion officials said at a recent Society of Automotive Engineers aerospace-vehicle conference. Engines for the ALS will also use simpler machinery and automated "warning light" monitoring systems.

To cut engine costs, Marshall and the Air Force Astronautics Laboratory (AFAL) are sponsoring development of lower-cost engine components. AFAL is sponsoring work on gas generators, combustion chambers, and engine-health monitoring systems. Results from the engine program will be used for an ALS full-scale development decision in fiscal year 1992.

Results from Air Force work will be integrated with LOX and LH_2 turbopumps, controls, and valves developed by Marshall, according to a manager of AFAL's space-transportation program. (According to ground rules established by the automotive engineers, all conference presentations were made on a not-for-attribution basis.)

Marshall's components will be based on designs studied in the center's space-transportation main-engine program. Before the ALS effort focused on expendable engines, main-engine studies at Rocketdyne, Aerojet, TechSystems, and Pratt & Whitney examined a reusable engine that operated at 2,400 to 3,200 psi. "The chamber pressure will probably be coming down," said a Marshall project engineer.

After completing component-level tests at the laboratories, Marshall plans to test the entire ALS engine at the National Space Technology Laboratories in Mississippi. ALS managers are now studying modification requirements for NSTL's SSME test stand.

Components for ALS engines will be built with new fabrication techniques that use precision castings to minimize welds. Rocketdyne believes it can cut 50 to 60 percent from the $3 million cost for an SSME thrust chamber. The ALS engine chamber will only need eight welds, according to a senior Rocketdyne ALS official. The four-fold reduction in welds will lower costs and improve reliability.

Pumps and injectors will also use precision castings as well as new materials that will not need the protective coatings. These improved designs should result in a $14-million reduction from the cost of an SSME, the Rocketdyne official said.

Another $7.5-million reduction will come by relaxing engine-design specifications. In addition to a gas generator cycle and lower chamber pressure, expendable engines will need fewer inspections. Subcontractors will design components to government specifications rather than the more stringent requirements set by Rocketdyne.

Other cost reductions will be achieved if at least 50 engines are built per year for at least 10 years. With a large production run, laser processing and nondestructive computer-tomography inspections can cut $5 million from the cost of each engine.

Marshall and AFAL are also cooperating on designs for ALS booster engines. This work includes studies of reusable and expendable LOX/hydrocarbon engines.

Liquid-booster engines could use methane, RP-1, or propane fuel to create 625,000 to 750,000 pounds of thrust at low altitudes (half the thrust produced by Saturn F-1s). Marshall's booster program previously examined using LH_2 for a "tripropellant" engine, but the ALS program prefers an engine that only needs LOX and hydrocarbon fuel.

Engine designers believed they needed LH_2 coolant to reduce "coking"—carbon deposits produced on copper engine parts during combustion. But recent sub-scale test firings at Aerojet and Rocketdyne suggest that coking can be reduced by using advanced materials that will not react with methane.

AFAL is also examining advanced solid rocket boosters, which would cost $800,000 each. These boosters would use monolithic fiber casings, eliminating the need for joints and O-rings. Test firings of boosters up to 36 inches in diameter suggest that nozzles can be eliminated from small boosters to reduce costs even more.

APPLIED GENETICS NEWS

DNA Fingerprinting Gains Acceptance

By identifying individuals as definitely as do regular fingerprints, DNA fingerprinting promises to revolutionize the analysis of semen, blood, hair, and other samples left by criminals. Until recently, however, the forensic use of DNA fingerprinting has been somewhat limited because the method requires micrograms of DNA, which means several hairs, or blood and semen in amounts larger than what is often found at a crime scene.

Now two research teams, taking different approaches, have developed DNA analyses that can be performed on nanograms of DNA, an amount typically found in a single strand of hair. This is an important benchmark, since hair is commonly found at crime scenes.

One of the new techniques is that developed by researchers at Cetus Corporation of Emeryville, Calif., and at the University of California in Berkeley. They have demonstrated DNA typing of single hairs using the PCR (polymerase chain reaction) gene-amplification process. Hair is especially difficult to work with because it contains limited, often degraded DNA. Using PCR, specific regions of a gene can be greatly amplified from as little as a single molecule of DNA, and even months-old, shed hairs meet this criteria. The amplified gene is polymorphic, meaning that it varies from person to person. This variation is used to identify, or type, individuals.

The PCR gene-amplification method which Cetus developed three years ago has been steadily changing the face of molecular biology. Traditional methods of copying genes or the proteins for which they code typically takes weeks, but PCR amplification can produce millions of copies in less than a day. With the PCR method, researchers using both fresh and shed hairs have succeeded in making enough copies of one small DNA region, a portion of a gene, to perform three kinds of typing on it. By looking at differences in the length and/or base sequence of that gene, they could classify individuals into 21 types.

Another method developed by Cellmark Diagnostic, a U.K. company, requires long, intact DNA chains, but the Cetus method can copy and type DNA that has been degraded by long exposure to light or enzymes. In the Cellmark technique developed by geneticist Alec Jeffreys at the University of Leicester, the DNA is cut into fragments that are arranged according to length by electrophoresis. The fragments that contain repeat sequences are tagged with radioactive probes so they can be visualized. The resulting pattern, which resembles a supermarket bar-code, is a DNA fingerprint. With this method, the chances of two unrelated people having the same DNA fingerprint are, on average, 1 in 30 billion. Shed hairs typically contain less than 10 nanograms of DNA, and being able to type them is particularly important because they are the most common hairs found in forensics.

Cellmark has recently modified its technique, making it more sensitive. Instead of using the original repeat-sequence probes, which are relatively short molecules, the researchers made new "locus-specific" probes out of selected DNA fingerprint fragments. These larger probes are able to carry more radioactivity, enabling researchers to detect DNA levels as low as 20 nanograms. This allowed the group to use the technique on a single hair root.

It is estimated that with a test made of four of the new locus-specific probes, the chances of two people having the same pattern would be one in a million, on average. The Cetus technique is less discriminating, but by looking at several different genes, Cetus researchers expect to achieve comparable values within the next few years.

As part of its collaboration with Eastman Kodak Company, Cetus plans to introduce a kit for the PCR method of DNA analysis that could be used by police crime laboratories. The companies expect their kit to be available during 1989.

Laser Energy Used to Unblock Arteries

A new procedure to unblock human coronary arteries with direct laser energy was performed in March on a patient in Methodist Hospital in Minneapolis. The procedure uses the LASTAC system, designed and

manufactured by GV Medical Inc. of Minneapolis.

LASTAC is the first integrated system that combines the use of direct laser energy, fiber optics, and balloon angioplasty catheters. The system has been used successfully in over 130 clinical cases on leg arteries since May 1986. The system is now operational at 17 sites, both domestically and internationally.

Dr. Nordstrom, a cardiologist at Methodist Hospital, used the LASTAC system when he applied direct laser energy to his patient's blocked right coronary artery.

James Grabek, president and chief executive officer of GV, cautioned that this is the first case in a long investigative process, similar to the process involved in the development of the technology for use in leg arteries.

The LASTAC system uses a balloon catheter to position a laser delivery fiber close to the blockage in the diseased artery. Laser energy is then used to vaporize the blockage, opening a channel and freeing the blood to flow through the artery once again. The laser vaporizing process is capable of opening blockages that in most cases would have necessitated surgery.

As the Methodist Hospital experience indicates, the procedure can be performed in a community hospital in a nonsurgical setting, using only a local anesthetic and with a considerably shorter hospital stay than for surgery.

InforMED

Study Compares "Clot Busters" for Heart Attacks

Abbott Laboratories has announced a major clinical study to determine the most efficacious, cost-effective regimen of thrombolytic therapy in the treatment of heart attacks. The study, known as TAMI-5, directly compares three drug regimens: urokinase, tissue plasminogen activator (TPA), and a combination therapy involving the simultaneous infusion of TPA and urokinase. Urokinase is marketed by Abbott under the brand name Abbokinase.

Thrombolytic therapy is rapidly emerging as a preferred treatment for persons who have had heart attacks. This therapy involves the use of potent drugs to dissolve the blood clots that cause most heart attacks. Dissolving clots quickly rapidly restores proper blood flow to the heart and minimizes damage to the heart muscle.

"TAMI-5 is designed to be the pivotal, definitive study on how to use thrombolytic therapy in treating heart attack," said Dr. Arthur Sasahara, venture head of thrombolytics research. "Unlike earlier studies, TAMI-5 will address long-term mortality, cost effectiveness, and the role of angiography as part of the treatment strategy." TAMI is an acronym for thrombolysis in acute myocardial infarction.

The TAMI-5 study will be carried out at five centers: Duke University in Durham, N.C., the University of Michigan in Ann Arbor, Riverside Methodist Hospital in Columbus, Ohio, the University of Vermont in Burlington, and Baptist Hospital in Memphis, Tenn. A total of 450 patients will be enrolled in the study. Final results should be available early in 1989.

"Previous studies have indicated that both urokinase and TPA are effective in dissolving blood clots in the heart," said Sasahara. "However, one of the most important factors in increasing heart-attack survival rates is making sure that the clots do not form again, blocking blood flow to the heart. We are supporting TAMI-5 because a pilot study, TAMI-2, indicated that a combination of thrombolytic agents may be the most effective way to restore blood flow to the heart on a long-term basis." The study will also generate detailed cost data, according to Sasahara.

"The true cost of thrombolytic therapy involves much more than the cost of the drug alone," he said. "Many other factors—such as side effects and length of hospitalization—must be considered. TAMI-5 will generate detailed cost data for these three important methods of treatment. Our goal is to determine which treatment regimen is most cost-effective," he said.

Abbokinase is currently approved for use in dissolving blood clots in the lungs and for direct infusion into the coronary artery immediately after a heart attack. To expand the use of Abbokinase, Abbott is seeking FDA approval to allow the drug to be intravenously administered to heart-attack victims.

ARTIFICIAL INTELLIGENCE

SYNAPSE CONNECTION

NeuralWare Technology Has Wide Application

The Analog Adaptive Pattern Classification System (AAPCS) from NeuralWare Inc. of Sewickley, Pa., is a breakthrough in applying neural networks to solve real-world problems. This new technology is suitable for a variety of applications. Candidate applications in the financial community include advanced trading systems, improved risk management, integrating multiple data feeds, smart broker workstations, fraud detection, and personnel performance monitoring. Candidate industrial applications include inspection systems, character recognition, and image understanding.

The system was originally designed to solve the problem of helping to manage an investment portfolio. A portfolio manager tells the system which securities he likes or dislikes. From that information, the neural network learns what is important in selecting securities. It uses that "knowledge" to search through a very large number of securities, applying what it has learned and suggesting potential investments. It can also critique an existing portfolio, warning of possible troublesome investments. One of the outstanding features of the system is its ability to adapt to changing decisions made by the manager.

According to its inventor and NeuralWare's founder, Casimir Klimasauskas, "In developing this network, we started from a list of customer requirements. Rather than trying to fit our customer's problem to existing technology, we used basic concepts from neural-network technology to develop a custom-engineered network tailored to solving our customer's needs. This approach allowed us to build on the strengths of different network types and engineer-in features such as confidence levels and an 'explain' function. The result is a very powerful adaptive system for developing neural-network-based expert systems."

The AAPCS is only one of the ways in which NeuralWare is diversifying. Starting with NeuralWorks Professional I (a neural-network development system), the company has moved into hands-on applications-oriented seminars, on-site custom-designed seminars, feasibility studies, application consulting, and custom-engineered networks. NeuralWare has expanded in several areas in response to customer requests. While NeuralWorks Professional I is getting a whole new face, an advanced version, NeuralWorks Professional II, was scheduled to be launched early this summer.

COMPUTERS

ANDREW SEYBOLD'S OUTLOOK ON PROFESSIONAL COMPUTING

New Programming System a Boon to 3-D Graphics

HOOPS—the Hierarchal Object Oriented Programming System from Ithaca Software—is a collection of graphics tools rolled together and treated as a single unit. The various tools and their interactions are uniquely structured, so HOOPS is not easy to explain in a few quick words.

First of all, HOOPS has two personalities: It is both a computer subsystem—a distinct software environment for 2-D as well as 3-D graphics development—and a device/computer interface.

As a subsystem, HOOPS is a library of powerful graphics routines for applications in almost any field, from science and engineering, to business in general, to TV and entertainment. Object-oriented, not procedure-driven, HOOPS provides all the software tools to define, transform, render, and interact with 2-D and 3-D graphic objects.

Now here's the payoff: With its structured tools and actions, HOOPS automates 50 to 60 percent of graphics programming.

HOOPS is device- and computer-independent and acts like a glue between its various supported computers, graphics devices, and operating systems. That means that vendors need only write to HOOPS, because HOOPS automatically provides the built-in glue. Written in system-independent C, HOOPS can be invoked from MS-DOS, C, Fortran, or Pascal applications.

The price for single-use licenses ranges from $575 (personal computers) to $2,000 (workstations). Quantity, site, source, educational, and OEM

discounts are available.

Perhaps the best way to explain what HOOPS is all about is to say that PC-based HOOPS (and other low-cost graphics tools) will do for 3-D graphics what WordStar (and other low-cost word processors) did for word processing.

To run at all on PC platforms, HOOPS needs new and very high levels of compute-power. Enter Nth Graphics's Nth 3-D Engine. Initially, Ithaca Software developed HOOPS to run on high-end workstations under Unix, but that company has since released its MS-DOS version for PCs (which also runs under OS/2). And, the PC version is easily recompiled for target graphics engines, such as the Nth 3-D Engine. Together, the transputer-based Nth 3-D Engine and HOOPS comprise a new and compelling force in graphics systems.

A PC-AT platform equipped with a HOOPS/Nth 3-D Engine can provide wireframe and shaded graphics at speeds found only in $50,000 to $70,000 workstations—but for less than $15,000 complete. In short, HOOPS and the Nth 3-D Engine provide an AT with the graphics power of a VAX 8600.

On top of that, there's vendor portability: HOOPS graphics applications developed under Unix can be ported to the souped-up ATs without changing any HOOPS calls. The reverse is also true.

Almost certainly in the next year, HOOPS will run on the Mac II. When that happens, HOOPS applications can be moved back and forth between Unix, MS-DOS, and Mac platforms.

On the output side, the Nth 3-D Engine acts as a graphics controller and drives CRTs up to 1,280×1,024 resolution, at a 60-Hz noninterlaced refresh rate. Users have a choice of 256 colors from a palette of either 4,096 or 16.7 million colors.

The Nth 3-D Engine is a single plug-in board with HOOPS already built in. Prices start at $5,995, and several expansion options are available.

Anyone interested in desktop graphics, especially the impact of HOOPS combined with the Nth 3-D Engine, should get a copy of *3-Dimensional Computer-Aided Design on Personal Computers—A Primer on Graphics Technology*, a 15-page report.

Advanced MILITARY COMPUTING

Air Force Speeds Cockpit Software

The design of cockpit software will be speeded 20 to 30 times by a project at the Air Force's Aeronautical Systems Division (ASD) at Wright-Patterson AFB in Ohio.

Jim Fileccia, program manager for the Rapidly Reconfigurable Crewstation (RRC), told *Advanced Military Computing* that the system could eventually allow Air Force logistics centers to reprogram cockpits to customize them for special missions. Fielding of the system, which is part of the Air Force's Forecast II avionics project, will occur in the early 1990s, Fileccia said.

Future cockpits to be programmed by the system will be infrared touch-control video displays, he added. "By 1998, we'll be using liquid-crystal technology [in cockpits]," Fileccia said.

Some observers believe the cockpit of the future will require the pilot to wear a helmet inside which he will see a digital display of the terrain and threats. ASD is also working on that technology, called the Visually-Coupled Airborne Systems Simulator, or VCASS. A key advantage of such systems is that they protect pilots from blinding by laser light—an unpleasant and growing feature of air warfare.

RRC software is written in Ada. Soon it will run on an ELXSI computer Fileccia's group plans to buy for the project, which is now in its prototype stage. "All the source code is in Ada so contractors can use it," Fileccia said.

He said the compilers used on the project, including one from Verdix, were working well, but "Ada hasn't really cleaned up its act for I/O [input/output]."

Other groups working on the project included STARS (Software Technology for Adaptable Reliable Systems), an Air Force software program that gave money for development of graphics and input/output technology. A General Electric group in Daytona Beach, Fla., also participated.

"What we're after is to get people with limited software ability to maintain software and generate software," Fileccia said.

The RRC system includes a "personality module" used to customize the software to the target computer.

"We've built a simplified version of an automated

layout center," Fileccia said. "We can take a picture, lay it out under an iconics camera, and the system will generate the software in four hours." The system determines where displays and switches will lie in the cockpit, and provides the software to run them.

Previously, cockpit design took months or years, the Air Force said. "Then, if the using command wasn't happy with it or discovered a deficiency in the design, the process of making changes took several more months or years," Fileccia added.

The system could be used to design space-mission crew stations. The Air Force does not yet have an agreement with NASA for that function.

FIBER OPTICS

LASER REPORT

GTE Claims Laser Speed Record

Scientists at GTE Laboratories in Waltham, Mass., claim to have set a new world speed record by developing a diode laser that operates at 22 billion cycles per second—fast enough to send 200 to 400 separate video channels over an optical fiber. The development tops the previous laser speed record of 18 billion cycles per second set by GTE in 1986.

"These high-speed lasers will play an important role in taking advantage of the enormous transmission capacity of optical fiber," says Dr. Robert Olshansky, senior staff scientist for GTE Laboratories. "One strand of commonly used optical fiber is capable of carrying information at data rates of a 100 billion bits per second or more. With a faster laser, more information can be transmitted through an optical fiber."

In another development, GTE's new laser radar equipment passed a major technological test in the space-flight mission of Delta 181 last month. The laser system, built by GTE Government Systems Corp. in Mountain View, Calif., was tested in the Delta mission for its ability to locate and track spaceborne objects.

While tracking and pointing with high precision, the laser radar equipment automatically measures azimuth, elevation, and range by transmitting a laser pulse to a target and measuring the angle of return and round-trip time. The infrared laser interrogates a target with short-duration laser pulses 500 times per second.

Work on the laser radar program was conducted by GTE under a subcontract from the Johns Hopkins Applied Physics Laboratory.

MFOC NEWSLETTER

FOG-M Brings Fiber Optics to the Battlefield

The Fiber Optic Guided Missile (FOG-M) program, a project for the U.S. Army Missile Command being conducted out of Redstone Arsenal, is nearing product realization.

AT&T Bell Laboratories has been under contract to the U.S. Army since 1985 to adapt fiber-optic technology to the deployment and guidance of missiles and other weapons. AT&T has developed a data-link system for the FOG-M program that provides ground-to-air communications for a ground-launched, non-line-of-sight, defense/anti-armor missile system. The state-of-the-art FOG-M system brings the advantages of fiber optics to the battlefield, and takes us one step closer to the battlefield of the future—one that removes people from the line of fire.

In order to build on current technology and make the most of manufacturing efficiencies, AT&T Bell Laboratories attempted to use existing AT&T products wherever possible.

The AT&T FOG-M data-link system employs high-strength depressed cladding single-mode fiber. The fiber is similar to that used in undersea cable for the first trans-Atlantic and trans-Pacific fiber-optic cable systems. The fiber has excellent bending resistance, low loss, and allows for long-length systems with superior resistance to the effects of the environment. The fiber is supplied wound on a FOG-M bobbin, which is configured to allow for smooth and rapid payout as a missile is launched.

AT&T is continuing to move fiber-optic technology into new areas, such as the FOG-M program. This same concept will be adapted to other types of weapons and to robotics for military or hazardous industrial uses in the future.

Fujitsu Develops Long-Distance Photo Receptor

Using flipchip fabrication technology, Fujitsu Laboratories has developed a highly sensitive, high-speed photo-receptor optoelectronic IC that enables 70 kilometers of repeaterless transmission with currently available optical-fiber communications technology. Its sensitivity of 1.4 microwatts during communications at 1.8 gigahertz was said to be a new record for OEIC devices.

The prototype device consists of an indium, gallium-arsenide amplifier circuit substrate measuring 1.4×0.8 millimeters and an indium-phosphor photo-receptor element measuring 0.2 sq. millimeters. The photo-receptor element is welded to the substrate with gold alloy to comprise a flipchip device.

Current technologies in fabricating photo-receptor OEICs include the wire-bonding method and the monolithic method. While the wire method makes fabrication simple, the device is noise prone and has low sensitivity. The monolithic method features high sensitivity, but has problems in the fabrication process due to difficulties in combining materials and fabricating the photo-receptor element.

The flipchip process that merely requires welding is simple and features low noise characteristics. Researchers say they will redesign the device and that Fujitsu Ltd. will handle commercial production.

TELECOMMUNICATIONS

LAN

SynOptics, TRW in $5-Million Technology Deal

SynOptics Communications Inc. and TRW Information Networks Division have signed a technology exchange agreement worth $5 million over the next five years. The agreement calls for the integration of SynOptics' Ethernet transceiver with TRW's custom LAN offerings. The Ethernet transceiver is a chip-level, unshielded, twisted-pair LattisNet with 10-megabit-per-second capability.

The specific TRW products that will be used with the SynOptics VLSI chip are the ACU 2000 communications server and PC 2001 Ethernet network interface cards.

The ACU 2000, a Transmission Control Protocol/Internet Protocol (TCP/IP) advanced connector unit, provides a multiple LAN interface for two to 160 asynchronous or synchronous terminals or host data-processing devices. The ACU 2000 provides connectivity to Ethernet and the choice of an alternate LAN interface. With the incorporation of the SynOptics chip, LattisNet becomes a primary LAN interface choice for TRW customers, in addition to thin Ethernet, StarLAN, integrated TRW two-megabit-per-second dual cable Broadband modem, or 5- to 10-megabit external Broadband modem. Any device port can be software configured to be synchronous or asynchronous.

TRW's Ethernet network interface card, the PC 2001, integrates several network protocol drivers on the board for users of MS-DOS or Xenix personal computers. Popular TCP/IP protocols it will support are File Transfer Protocol (FTP), Virtual Terminal Protocol (VTP) and interfacing to SMTP. In combination with TRW's OS Connection software, these network interface cards will turn a personal computer into a fully functioning TCP/IP data-processing device.

"The incorporation of the LattisNet Transceiver chip into our product line provides TRW with an unshielded twisted pair solution for our customers," said John Cahill, director of marketing for TRW Information Networks.

Because of TRW's established government presence, the agreement allows SynOptics Communications to expand its activities in the government sector.

ISDN

Southern Bell Launches Commercial ISDN

Blending computer and telecommunications technologies into a single network, Southern Bell has inaugurated the nation's first commercial, multi-user application of ISDN.

The limited commercial offering of ISDN, in Atlanta, Georgia, provides a variety of sophisticated voice, data, and video services over Southern Bell's local network and will make possible a wave of new communications services for business and home use.

Southern Bell's first ISDN customers are Prime Computer, AT&T Network Systems, Hayes Microcomputer Products, SunTrust Services, and Contel. A sixth customer, Digital Equipment Corp., was announced at the inaugural ceremony.

Southern Bell vice president for Georgia operations Walter W. Sessoms spoke at a ceremony marking the cutover of the $2.8-million switching system at Southern Bell's central office in Dunwoody, Georgia, the first location in the nation to offer commercial ISDN service to multiple customers.

The ISDN cutover at Dunwoody is part of a $1.6-billion effort by the company to completely computerize its Georgia central offices by the end of 1989. The "State of the Art Statewide" program will give Georgia one of the nation's most advanced telecommunications networks.

AT&T Network Systems was the first Southern Bell customer to cut over to ISDN service when 337 employees began using Basic Rate ISDN lines coupled with Southern Bell's Digital ESSX Service at its Southern regional headquarters in north Atlanta. Each ISDN line provides two voice or data channels and one 2B+D signaling channel.

Southern Bell has leased space in AT&T's Southern regional headquarters, where it has installed a remote ISDN switch. This switch is operating off the Dunwoody central office's 5ESS digital switching system. In addition to AT&T, Southern Bell expects to serve a number of other ISDN customers from that remote switch.

Hayes Microcomputer Products of Norcross, Georgia, a maker of communications products for personal computers, became the second Southern Bell ISDN customer when it began using a total of 25 Basic Rate ISDN lines for engineering development, testing, and demonstration of its Hayes ISDN personal-computer expansion board.

In addition, the company is considering using ISDN for electronic mail, FAX transmission, and other applications. Southern Bell is using T-1 carrier technology to bring the digital circuits to Hayes' Norcross location.

SunTrust Service Corp. will use 50 Basic Rate ISDN lines in its banking offices in Dunwoody. Prime Computer will use 25 Basic Rate lines as well as one Primary Rate line in its Dunwoody branch office.

TELEVISION DIGEST

High-Definition TV Myths Debunked

Wishful thinking and panic seem to be mixed in roughly equal proportions where HDTV is concerned. Based on the history of the television industry, many of today's arguments and statements about advanced TV systems seem to be grounded firmly in myth. Here are some common conceptions that are at least partly contradicted by fact, history, or common sense:

1. Americans desperately want better pictures, and public opinion is forcing the industry to adopt advanced TV systems.

A recent MIT study, augmented by opinion research of HBO and CBC, begins to put the situation in perspective. While Americans may be most demanding about program material, they're notoriously passive in their acceptance of technological picture deficiencies.

There's no question that Americans—or any viewers—can be educated about the advantages of good pictures. Larger-screen TV sets particularly will cry out for pictures that can be viewed from closer distances. But all available information indicates that the U.S. demand for HDTV may arise from national pride, the threat of competition, or visions of future markets—but not from any spontaneous demand by the viewing public, contentedly watching Knott's Landing on maladjusted sets with 25-year-old antennas, worn-out lead-in wires, and 150 lines of horizontal resolution.

2. High-definition VCRs are "on the boat" and threaten to preempt both broadcast and cable in HDTV.

It's true that the broadcasting and cable industries were jolted severely by the announcement

of Super VHS—which meant that, for the first time, consumers could create at home a picture better than they could get from outside (whether or not they want it). This fact, perhaps more than any other, triggered serious discussion of improved transmission in the United States.

But there's a big difference between Super VHS and HDTV: S-VHS can be played back over any standard TV set (but only sets with S terminals get the full benefit of the improved picture). To believe consumers are going to pay multi-thousands for HD VCRs and then more multi-thousands for special TV sets just to play them back is to live in a world of fantasy. There's no evidence that any manufacturer would be so foolhardy as to ship a consumer HD VCR today, simply because no set is available to play it through.

3. Japan is switching to HDTV broadcasting.

Japan's widely touted adoption of NHK's MUSE system, which is basically incompatible with the NTSC system used in both Japan and the United States, currently is scheduled for direct broadcasting from satellite (DBS), which for the foreseeable future is expected to beam programs largely to sets in public places rather than in homes. It's been less publicized that Japan also is developing an advanced TV system compatible with NTSC—called EDTV—for terrestrial broadcasting. After Sarnoff Labs' Advanced Compatible TV (ACTV) system was announced in the United States, the Japanese announced a new goal of two-stage EDTV—first one with today's standard aspect ratio, and a second with a wide screen, but both compatible with existing Japanese (and U.S.) NTSC broadcasts (and incompatible with NHK's 1,125-line system).

4. There's a race on among broadcasters, cable operators, DBS, and VCR manufacturers, and we could end up with two or more incompatible systems.

There may be a race, but nobody wins with incompatible systems. The entire history of broadcasting and consumer electronics dictates the choice of a single system (or systems compatible with one another)—compatible with the current NTSC standard. Any program source sending out an incompatible signal will start out transmitting to no audience, and probably end up that way. In TV's early days, the FCC approved broadcasting in an incompatible color system, and no sets ever were sold to receive the signals—at a time when about 25 million standard black-and-white NTSC sets were in use. Today, 162 million NTSC color and monochrome sets are in use in the United States.

As for broadcasters, cable operators, or others selecting different HDTV systems, that undeniably is a possibility because of different requirements for different systems. But it's inconceivable that consumers will put two different TV sets side by side to watch programs from two different standards. And it seems obvious that systems compatible with the 162 million TV sets in the United States will succeed. It's been suggested that a universal digital set could be built to accept all incompatible standards, and that certainly is possible, but in the near future it probably would be much too costly to sell as a consumer product.

5. There's an immediate market for $10-billion, $20-billion (or name any figure up to $400 billion) worth of new HDTV sets as replacements for existing models once HDTV broadcasting begins.

The key word is "immediate," and once again history says no. It took 10 years from the introduction of color to the first million-color-set year. Since there's considerable agreement that the impact of HDTV wouldn't be as great as that of color, the buildup of a new sales boom could come even more slowly. Also working against an early boom is the extremely high cost of widescreen direct-view or projection sets—we keep hearing figures such as $3,000 in mass production—expected to come down only gradually.

6. HDTV will come along in about five years.

Based on the time it took to develop standards, allocate frequencies, etc., for black-and-white and then for color TV—and considering what's at stake—10 to 20 years seems far more likely, allowing time for the usual court challenges. If anything, the situation is more complex today than in TV's early days, because of the multiplicity of delivery systems, the requirements for field testing, etc. At least theoretically, HDTV could come more quickly to cable than to broadcast, but almost any type will require complex rebuilding of systems. Advanced systems short of HDTV not requiring frequency-spectrum reallocation could come more quickly.

7. The switch to HDTV widescreen won't pose a programming problem even in the early days because of the thousands of movies that have been shot in the widescreen process.

Movies in their widescreen form are incompatible with the aspect ratio of existing narrow-screen TV sets. To convert a widescreen movie to current TV

screen proportions, it must be "descoped," or virtually reshot electronically on tape so major action occurs within the TV screen's borders. If raw widescreen movies were shown on compatible HDTV, viewers with standard sets would miss much of the action, and the majority of viewers who would be watching on standard TV sets might tune out and ratings would suffer. Electronic "pan and scan" systems have been proposed to solve this problem, but these are complex and many impose added expense on the consumer through more complex TV sets.

ENERGY

Coal & Synfuels Technology

Electricity/Methanol Plant Makes Both Cheaper

Utilities planning to install gasification, combined-cycle (GCC) plants may be able to make electricity cheaper by co-producing methanol, says the Electric Power Research Institute (EPRI).

EPRI envisions using methanol as a storage system, which would allow utilities to build a smaller plant but still have peaking capacity. Utilities could save money by sizing the gasification unit—the most expensive component—for average demand. In off-peak periods when the plant's maximum output wasn't needed to make electricity, the plant could produce methanol.

During peak demand periods, the methanol could be pulled out of storage and fired in the boilers, EPRI said. The system would make methanol-from-coal and electricity production from GCC both cheaper, the research organization said.

EPRI is hoping to test the idea at the Cool Water coal-gasification demonstration plant in Daggett, Calif. The plant's federal subsidy runs out next year, and program managers are looking for ways to keep it running. EPRI is preparing a proposal for possible submission under the second round of the federal Clean Coal Technology program.

The project would use the once-through methanol process developed by Chem Systems Inc. with backing from EPRI and the Tennessee Valley Authority. Air Products and Chemicals Inc. is developing the technology further. The four organizations jointly submitted a proposal under the first round of the federal clean-coal program for a 35 tons/day once-through methanol demonstration at TVA's Muscle Shoals, Ala., facility. The project would be added to TVA's 200 tons/day Texaco coal-gasification and gas-cleanup unit.

The Energy Dept. selected the TVA project as a runner-up, and has asked the utility to keep its offer open in case negotiations break down with sponsors of the remaining projects under the first round. If the TVA project were selected, EPRI would have to decide which of the two methanol proposals it wanted to pursue, an EPRI researcher said.

The Cool Water project would be much larger, at an estimated 125-150 tons/day, and would demonstrate the co-production of methanol and electricity, whereas the TVA project would demonstrate methanol only.

The project also would look at making sulfur removal cheaper. The Cool Water system, which uses a Texaco gasifier, removes 99.9 percent of the sulfur from coal, but even more sulfur would have to be removed in the production of methanol because the catalyst used in the reaction is easily poisoned by sulfur.

EPRI has been kicking around the co-production idea for about a year, the researcher said. No new technology has emerged suddenly to make the system possible, but researchers began to understand better how the existing technologies could work together. "We've always been looking at plant economics and we've always been thinking about methanol. But we never thought about size, and we never realized we had the tool to do it," the EPRI researcher said.

The proposal comes at a time when methanol is gaining increasing national attention as an alternative transportation fuel. The implications aren't lost on EPRI researchers, who see the fuel methanol market as another incentive for utilities to install GCC/methanol plants. Whether to sell the methanol or fire it in utility boilers would depend on the market price.

In the past, utilities have said that firing methanol in utility boilers made no sense because it cost more to convert natural gas—the predominant feedstock—to methanol than it would cost to burn it as the primary fuel. But utilities back then were speaking in terms of buying methanol and not producing it themselves on site, EPRI said.

Changes Germinate in Sterilization Industry

While the sterilization industry is vigorous, it is in a period of uncertainty about various methods. Contributing to this uncertainty are questions over gamma radiation in the food industry and ethylene oxide in the medical-product industry. New methods becoming available include electron-beam radiation, alternative chemicals for gas sterilization, and advances in materials technology.

Aggregate U.S. product sales and contract services amounted to about $715 million in 1987, and sales are estimated to reach over $1 billion by 1992, with the industry experiencing an 8.8 percent average annual growth rate. This aggregate is divided into sterilization products, which take over 69 percent for sales of $495 million in 1987, and sterilization services, which take the remaining 30 percent, or about $220 million in sales.

One of the largest parts of the business is sterilizing filters for gases and liquids. These sales, which were $397 million in 1987, are expected to reach $760 million in 1992. Growth is being stimulated by expansion of the biotechnology industry, which uses heat-sensitive media to produce proteins, and by the food and beverage industry, which is converting to aseptic fill processes.

The troubled area is ethylene oxide. Product sales in 1987 amounted to slightly over $70 million, which consisted mainly of consumable gases rather than capital equipment. Overall sales in this area may decline to about $51 million in 1992.

Offsetting this projected decline will be a partial replacement of EtO with alternative gases. Some replacement possibilities include vapor-phase hydrogen peroxide and chlorine dioxide, which would take 10 percent of the gas sterilization business away from ethylene oxide. Fees for contract EtO sterilization services will, however, continue to increase from fees of about $200 million in 1987 to about $220 million in 1992.

New Products

OFFICE PRODUCTS

Model 745 answering machine. This phone machine resets itself after playing back messages and lets users retrieve messages remotely without a beeper. A four-digit security code prevents unauthorized access. $349. Dictaphone Corp., 3191 Broadbridge Ave., Stratford, CT 06497. (800) 342-8439. *Circle 1.*

1925 transcription monitor. This display console monitors the work flow in transcription systems using the company's Thought Tank recording machines. The console handles 16 recorders at once, indicating which recorders are in use, which have a backlog, and whether a recorder has priority jobs. From $2,095. Dictaphone Corp., 3191 Broadbridge Ave., Stratford, CT 06497. (800) 342-8439. *Circle 2.*

3+F/T network protecters. Two programs that protect data on networks based on the company's 3+ operating system. The DM program performs disk mirroring to prevent data loss and server downtime due to hard-disk failures. The SM program offers server mirroring to guard against failures in the server's processor, memory, power supply, or disk controller. $1,595 and $8,995, respectively. 3Com, 3165 Kifer Rd., Santa Clara, CA 95052. (800) 638-3266. *Circle 3.*

Advanced Word training program. A software program that teaches word processing with the personal-computer version of Microsoft Word. Explains how to create tables and text columns, how to use print-merge features for labels and form letters, and how to copy information from one document to another. From $750. Logical Training Systems Inc., 240 East Ave., Rochester, NY 14604. (800) 456-4677. *Circle 4.*

Alexsys filing system. Stores documents as images on 5¼-inch laser disks. The microcomputer-based system helps perform trend analysis, relationship comparisons, and testing. $15,000; $5,200 for software only. Courtland Marketing Inc., 10480 Little Patuxent Parkway, Suite 400, Columbia, MD 21044. (301) 740-8715. *Circle 5.*

CTX 200 phone console. Provides automatic hold and hold recall, night switching, and programmable ring delay. Handles 20 incoming lines and has a display that identifies each line by name. Also plays music or announcements for callers on hold. $995 per console; a $995 processing unit drives two consoles. Tone Commander Systems, Box 97039, Redmond, WA 98073. (800) 524-0024; in Wash., (206) 883-3600. *Circle 6.*

Desktop Presenter graphics system. Equips a personal computer to create graphic presentations. The product consists of a graphics card, graphics software, and printing software; it works with more than 40 graphics packages and various laser and ink-jet printers. Makes 35-millimeter slides when used with the company's PhotoMetric slide maker. $2,595. General Parametrics Corp., 1250 Ninth St., Berkeley, CA 94710. (415) 524-3950. *Circle 7.*

ESP slide system. This system creates and displays color images on a large-format or color monitor. Handles charts, artwork, and scanned images with 680×1,024-line resolution. Includes a personal computer, monitor, graphics controller card, and software. A typical configuration costs $19,900; software only is $3,000. Compugraphic Corp., 200 Ballardvale St., Wilmington, MA 01887. (800) 822-5524; in Mass., (508) 658-5600. *Circle 8.*

FutureLink information service. Delivers data on worldwide futures markets by satellite. The service provides such information as prices and commentary from experts. Subscribers rent software and a modem card; options include a satellite dish and an IBM PC-compatible computer. $74.95/month. Oster Communications, 219 Parkade, Cedar Falls, IA 50613. (800) 553-2910; in Iowa, (800) 772-2106. *Circle 9.*

ID-2000 digital security system. Electronically stores images, signatures, and text to produce photo-identification cards. Handles 2,000 black-and-white portraits or 200 color photos; optional modules expand storage to 80,000 black-and-white or 8,000 color images. Comes as a stand-alone workstation for about $12,000, or ready for connection to mainframes or networks for about $16,000. Polaroid Corp., 575 Technology Square, Cambridge, MA 02139. (617) 577-2000. *Circle 10.*

KAR database builder. Automates the creation of computer-assisted retrieval (CAR) microfilm databases. Eliminates manual entry by capturing bar codes printed on documents; the codes include such data as document type and invoice number. A scanner reads this data and sends it to a personal computer for verification, then to the database mainframe. $15,500. Eastman Kodak, 343 State St., Rochester, NY 14653. (716) 726-2263. *Circle 11.*

KAR-6500 information system. Based on an ADDS Mentor 6000 minicomputer, this system expands to accommodate 20 users who need simultaneous access to as many as 30,000 documents per day. Works with computer-assisted retrieval (CAR) microfilm databases. $80,000. Eastman Kodak Co., 343 State St., Rochester, NY 14653. (716) 726-2263. *Circle 12.*

Keyboard support arm. Attaches to a desk to swing a keyboard out of sight when not in use. The arm needs 18½ inches of clearance and measures 23½×11 inches. $159. Hamilton Sorter Co. Inc., Box 8, Fairfield, OH 45014. (800) 543-1605; in Ohio, (800) 543-8334. *Circle 13.*

Kompakt movable-shelf file. A walk-in, electronically controlled filing system that links to computerized record and material control systems. Stores books, computer disks, and papers. Has a safety floor that shuts down the system when it detects 25 pounds. Price varies. Kardex Systems Inc., Box 171, Marietta, OH 45750. (800) 848-9761. *Circle 14.*

MAPS/EIS financial software. An executive information system that lets users manipulate, report, and graph data from MAPS accounting software, and also from spreadsheets for personal computers. The package is based on the 20/20 spreadsheet from Access Technology and runs on DEC

VAX minicomputers. $3,500 to $15,000. Ross Systems, 1860 Embarcadero Rd., Palo Alto, CA 94303. (415) 856-1100. *Circle 15.*

Medtrack FDA-audit software. Helps medical researchers comply with Food & Drug Administration audits. The package tracks bills of materials, engineering change orders, quality-control and sterilization procedures, and data and manufacturing procedures. $2,100. Innovative Applications, 557 Mount Auburn St., Watertown, MA 02172. (617) 924-0400. *Circle 16.*

Model 360 strip printer. This desktop printer produces strips of lettering from commands typed into its keyboard. The device offers more than 10,000 typefaces and sizes, and handles underlining, italics, boldface, shadowing, and math symbols. $2,195. Kroy Inc., Scottsdale Airpark, Box C-4300, Scottsdale, AZ 85261. (800) 328-1306; in Ariz., (602) 948-2222. *Circle 17.*

Office Works network software. Supports activities in networked offices. Various modules handle phone messages and electronic mail, provide document control, maintain name and address databases, and ease scheduling. $1,395. Data Access, 14000 S.W. 119th Ave., Miami, FL 33186. (800) 451-3539; in Fla., (800) 331-3960. *Circle 18.*

Perception hybrid PBX. A digital system that reduces telephone costs by taking advantage of reduced charges for certain lines. Provides 192 ports that accommodate stations, trunks, and data-switching interfaces. Measures 20×18×12 inches. Price varies. Toshiba America Inc., Telecommunications Systems Division, 9740 Irvine Blvd., Irvine, CA 92718. (800) 222-5805; in Calif., (714) 583-3700. *Circle 19.*

Photometric slide maker. Creates slides with 1,000 colors. The desktop unit offers on-screen previewing and shaded backgrounds. Resolution is 4,000 lines. The device works with 40 personal-computer graphics packages. $4,495. General Parametrics Corp., 1250 Ninth St., Berkeley, CA 94710. (415) 524-3950. *Circle 20.*

Q-DOS network software. Manages hard-disk computer systems linked by networks. The package handles 550 directories with 800 files per directory, and supports all MS-DOS file-management commands. It works with hard disks that store more than 50 megabytes. $249.95. Gazelle Systems Inc., 42 North University Ave., Suite 10, Provo, UT 84601. (800) 233-0383; in Utah, (801) 377-1288. *Circle 21.*

QuickMail electronic mail. Allows real-time conferences among Macintosh users. The software automatically generates transcripts of conferences and offers a public bulletin-board feature. Other features include automatic log-on and password security. $300 for 10 users. CE Software, 1854 Fuller Rd., West Des Moines, IA 50265. (515) 224-1995. *Circle 22.*

SV5035 slide/video converter. Transfers 35-millimeter slides to video signals. The converter accepts standard slides in 80-slide Kodak Carousel trays and provides random access to any slide. Zoom and scan features allow magnifications of 0.7 to 5 times. Images may be moved right, left, up, or down, and also rotated 10 degrees. $4,700. Eastman Kodak Co., Electronic Photography Division, 343 State St., Rochester, NY 14650. (716) 724-5787. *Circle 23.*

TermServer/Manager network devices. These two products work in Ethernet local-area networks. The TermServer server lets terminals communicate with a host computer. The TermManager unit sets access privileges for each TermServer port and keeps track of network errors and use, compiling statistics on each connection. TermServer costs $3,650 to $4,260; TermManager starts at $12,160. Data General, 4400 Computer Dr., Westborough, MA 01580. (508) 366-8911. *Circle 24.*

V-2050 video-conference system. Includes a color monitor, camera, and two-way sound system to equip a room for video conferences. $29,900 per site. PictureTel Corp., 1 Intercontinental Way, Peabody, MA 01960. (508) 535-7700. *Circle 25.*

■ COMPUTER HARDWARE

Discover 7320 flatbed scanner. Model 30 captures text at a rate of 40 to 60 characters/second. The system automatically reads multiple-column documents, including spreadsheets, in thousands of typestyles and sizes. It recognizes seven languages, including Swedish and Italian. Based on an IBM PC/AT or compatible computer; includes a 68020-based coprocessor card running at 16 megahertz with four megabytes of random-access memory. $13,950. Kurzweil Computer Products Inc., 185 Albany St., Cambridge, MA 02139. (617) 864-4700. *Circle 26.*

286 Portable computer. This 14-lb. unit has a 10-inch diagonal gas-plasma screen with a resolution of 640×400 pixels. The system includes a 40-megabyte hard disk, 640 kilobytes of random-access memory, a 3½-inch-disk drive, one serial and one parallel port, and a 16-bit expansion slot. Runs MS-DOS and OS/2 software. $4,995. Ogivar Technologies, 7200 Route Transcanadienne, Ville Saint-Laurent, Quebec, Canada H4T 1A3. (514) 737-3340. *Circle 27.*

390/391 24-pin printers. Both models feed from the bottom to prevent paper jams, printing 270 characters/second in draft mode and 90 characters/second in letter-quality mode. Model 390 accepts paper 3 to 9½ inches wide; the 391 handles paper as wide as 16 inches. Both models emulate the Epson LQ and IBM X/24 printers. $699 and $949, respectively. Okidata, 532 Fellowship Rd., Mount Laurel, NJ 08054. (609) 235-2600. *Circle 28.*

5000 MC personal computer. This 80386-based computer runs at 20 megahertz and has IBM MicroChannel architecture. The machine uses MS-DOS, SCO Xenix, and OS/2 software and has two megabytes of random-access memory that can be expanded to 16 megabytes. Also offers a 40-megabyte hard disk; a 1.44-megabyte, 3½-inch floppy-disk drive; and five Micro Channel-compatible expansion slots. From $6,499. Tandy Corp., 1700 One Tandy Center, Fort Worth, TX 76102. (817) 390-3549. *Circle 29.*

AcerServer 5200 network server. A file server built around an 80386 processor running at 20 megahertz. Comes with Novell NetWare software installed; includes an ESDI-drive interface. Offers a choice of 70- or 130-megabyte hard disks. Less than $9,000. Acer Technologies Corp., 401 Charcot Ave., San Jose, CA 95131. (408) 922-0333. *Circle 30.*

Artist 10 MC graphics board. Lets IBM PS/2 computers display 256 colors at once from a palette of 16.7 million. The board provides a noninterlaced resolution of 1024×768 pixels, a minimum bandwidth of 64 megahertz, and a variable scan-rate of 31 to 50 kilohertz. $3,595. Control Systems, 2675 Patton Rd., St. Paul, MN 55113. (612) 631-7800. *Circle 31.*

Colt personal computer. An IBM PC/XT-compatible computer with an 8088 processor running at 4.77 or 7.16 megahertz. The machine has 640 kilobytes of random-access memory and two 5¼-inch, 360-kilobyte floppy drives. Also has built-in CGA, MDA, Hercules, and Plantronics Color Plus graphic adapters. $899.95. Commodore Business Machines Inc., 1200 Wilson Dr., West Chester, PA 19380. (215) 431-9100. *Circle 32.*

CrystalPrint WP printer. Produces six pages/minute of text and graphics at 300×300-dot/inch resolution. Has 128 kilobytes of random-access memory. Emulates the Diablo 630; options allow emulation of

Hewlett-Packard's LaserJet Plus or Epson's FX-85 dot-matrix printer. Measures about 15×13×9 inches. $1,299. Data Technology Corp., 2551 Walsh Ave., Santa Clara, CA 95051. (408) 727-8899. *Circle 33.*

FlexNode 386 workstation. This 32-bit machine measures only 7×4½×15 inches. It runs at 20 megahertz and has one megabyte of memory and a 3½-inch-disk drive. Also offers four expansion slots; comes with a 101-key keyboard. $3,490. A version with a 30-megabyte hard drive and controller costs $3,990; a 50-megabyte model is $4,449. Advanced Logic Research Inc., 10 Chrysler, Irvine, CA 92718. (714) 581-6770. *Circle 34.*

KF-8200 document-processor board. This board takes up one slot in an IBM PC/AT or compatible computer to process high-resolution documents and large engineering drawings. The board has four or eight megabytes of extended or expanded memory, handles CCITT Group 3 and 4 image compression and decompression, and converts resolutions for image display and printing. A four-megabyte model is $4,050; an eight-megabyte version costs $6,700. Ko-Fax Image Products Inc., 2691 Richter Ave., Suite 108, Irvine, CA 92714. (714) 474-1933. *Circle 35.*

LP-76 laser printer. Delivers full-page graphics and text at six pages/minute. The device includes 512 kilobytes of memory that can be expanded to 4.5 megabytes, and nine resident typefaces. Prints type as large as 655 points; emulates Hewlett-Packard's LaserJet Series II printer. $1,995. Acer Technologies Corp., 401 Charcot Ave., San Jose, CA 95131. (408) 922-0333. *Circle 36.*

MH 216 hand-held scanner. Enters images into IBM PC/AT and compatible computers at a rate of 10 seconds/page. Resolution is 200 dots/inch. The scanning width is 8½ inches, and the device recognizes 16 shades of gray. Includes interface board and image-processing software. $995. Mitsubishi Electronics America Inc., Computer Peripherals Division, 991 Knox St., Torrance, CA 90502. (213) 515-3993. *Circle 37.*

Model 1030 personal computer. Built around an 8086 microprocessor running at 9.6 megahertz; compatible with the IBM PS/2 Model 30. The system provides 640 kilobytes of random-access memory and offers a choice of 5¼- or 3½-inch floppy-disk drives, plus four 8-bit expansion slots. Less than $1,400. Acer Technologies Corp., 401 Charcot Ave., San Jose, CA 95131. (408) 922-0333. *Circle 38.*

MP286L laptop computer. Includes an 11-inch diagonal display that shows black on white or vice versa. The system provides a 20-megabyte hard disk, 640 kilobytes of random-access memory (expandable to two megabytes), and a 3½-inch-disk drive. Runs OS/2 software; weighs less than 16 pounds. From $3,195. Mitsubishi Electronics, Computer Systems Division, 991 Knox St., Torrance, CA 90502. (213) 515-3993. *Circle 39.*

ScanMan scanner. This hand-held scanner lets users of the IBM PC/XT/AT and PS/2 scan images as large as 4×11 inches with 200-dot/inch resolution. Comes with software for manipulating images; works with programs such as PageMaker and PC Paintbrush. $299. Logitech, 6505 Kaiser Dr., Fremont, CA 94555. (415) 795-8500. *Circle 40.*

Star 2 laser printer. Offers 300×300 dot/inch resolution, one megabyte of memory, and 27 resident typefaces. The printer also stores as many as 128 typefaces in its memory. Emulates the Hewlett-Packard LaserJet Series II, Epson FX-80, and Diablo 630 printers. $2,195. Blaser Industries, 8300 East Raintree Dr., Scottsdale, AZ 85260. (602) 998-0400. *Circle 41.*

■ COMPUTER SOFTWARE

3+Reach/MCI mail interface. An extension to the 3+ network operating system that links 3Com's 3+Mail with various electronic-mail services, including MCI Mail, IBM Profs, Digital Equipment's All-In-One, Wang Office, and HP Desk. The interface lets 3+Mail users send messages that include attachments from an IBM PC or PS/2, Macintosh Plus, II, or SE. $595. 3Com Corp., 3165 Kifer Rd., Santa Clara, CA 95052. (408) 562-6400. *Circle 45.*

HandShake/GDT customer guide. Refers customers and sales prospects to the nearest outlet of a business for products or services. The program includes a computerized map of the United States and holds 32 pieces of information about each location. Prints reports; serves as a database of customer names and addresses. The software runs on IBM PC-compatible computers. $1,495. Geographic Data Technology Inc., 13 Dartmouth College Hwy., Lyme, NH 03768. (603) 795-2183. *Circle 46.*

Memory Lane text retriever. This program locates data on a hard or floppy disk that has as many as 7,500 files. From within any program, users can search for a word, number, or phrase; the program lists every file containing the search term and highlights the term. Users can mark text and transfer it to another file. Runs on IBM PC-compatible computers. $149. Group L Corp., 481 Carlisle Dr., Herndon, VA 22070. (703) 471-0030. *Circle 48.*

Spock database-query program. Lets users request information from Oracle databases in plain English. The program translates the query into the language of the

particular database, has three levels of security, and "learns" words and phrases. Runs on DEC VAX computers and uses IBM PC/AT, PS/2, or compatible workstations. $6,000 to $35,000. Dynamics Research Corp., 60 Frontage Rd., Andover, MA 01810. (508) 475-9090. *Circle 51.*

SunAccount accounting package. Translates and consolidates multicurrency accounts into a single base currency. Users can integrate accounts into one ledger and set up multiple currency-conversion codes linked to an exchange rate accurate up to nine decimals. Also works as an accounts-payable/receivable program. Runs on the IBM PC, IBM System/36, DEC VAX, and Unix-based systems. $3,500 to $100,000. Systems Union Inc., 244 East 48th St., New York, NY 10017. (212) 753-7777. *Circle 52.*

Vaccine PC data protector. This "vaccine" software guards against "virus" programs that can destroy data. The product discovers and eliminates infected files each time the computer boots. In addition, the software tests each program when it is being loaded and stops that program from being stored if it detects changes. Runs on the IBM PC/AT/XT and the PS/2. $92. FoundationWare, 2135 Renrock Rd., Cleveland, OH 44118. (800) 722-8737; in Ohio, (216) 932-7717. *Circle 53.*

COMMERCIAL/INDUSTRIAL

6200 portable pressure gauge. A pneumatic device that measures pressure on-site; it also checks for leaks and performs pressure-rate-of-change tests. The gauge automatically compensates for temperature changes and is not affected by gravity, vibration, or altitude. $3,850. Ruska Instrument Corp., Box 630009, Houston, TX 77263. (713) 975-0547. *Circle 54.*

Copper sprayer. This electric-arc spray gun shoots a mist of copper to coat aluminum connectors for electrical circuits. Looks and handles like a paint sprayer; runs on electricity and compressed air. $12,000 for a hand-held unit with power supply; other versions work with production equipment. TAFA Inc., Box 1157, Concord, NH 03301. (603) 224-9585. *Circle 55.*

Fiber Driver converter. Converts RS-232C signals into light pulses so devices transmitting data through the RS-232C interface can use fiber-optic equipment. The unit guards equipment from electrical damage or interference. $159. Black Box, Box 12800, Pittsburgh, PA 15241. (412) 746-5500. *Circle 56.*

Maxima drilling machine. A multiple-spindle drill for making printed-circuit boards. Drills holes from 0.004 to 0.250 inches in diameter with an accuracy of ±0.0002 inches. The machine has an RS-232C interface for transferring production data and 128 kilobytes of memory for calculations and logic operations. Available with four, five, or six spindles. $179,200 to $216,700. Pluritec U.S.A. Inc., 360-8 Knickerbocker Ave., Bohemia, NY 11716. (516) 567-0250. *Circle 57.*

Model 290 power amplifier. This 35-kilowatt amplifier provides 160 volts at 230 amps. The pulse-width-modulation device covers DC to 3 kilohertz and has an efficiency of 95 percent. $18,000. Copley Controls, 375 Elliot St., Newton, MA 02164. (617) 965-2410. *Circle 58.*

Operations Planner software. Helps predict the impact of changes in a manufacturing operation. The DOS package assesses the effect of changes in lead times, capacity, unit product costs, and other factors. Checks for errors, inconsistencies, and unrealistic inputs. Runs on an IBM PC/XT/AT or compatible computer with 640 kilobytes of random-access memory and two megabytes of hard-disk memory. $3,500. Palladian Software, 4 Cambridge Center, Cambridge, MA 02142. (617) 661-7171. *Circle 59.*

RPM-351 reactant purifier. This module works with metal organic chemical vapor disposition (MOCVP) machines to purify reactant gases. The stainless-steel device removes oxygen compounds and water vapor using a metal bubbling system. $2,800. Model RPM-301, which has a stainless-steel valve block for gas switching, costs $5,400. Emcore Corp., 111 Corporate Blvd., South Plainfield, NJ 07080. (201) 753-1311. *Circle 60.*

CONSUMER PRODUCTS

SuperZoom 300 35mm camera. This 20-oz. camera offers automatic focusing and automatic zooming with its 38- to 105-millimeter lens. $550. Olympus Corp., Crossways Park, Woodbury, NY 11797. (800) 443-0880; in N.Y., (516) 364-3000. *Circle 61.*

Air-traffic control simulator. This Macintosh program simulates an air-traffic control station, including a radar screen, status and command panels, a shift clock, and a wind-direction indicator. $49.95. HJC Software Inc., Box 51816, Durham, NC 27717. (919) 490-1277. *Circle 62.*

CDB486/586 compact-disc players. Two models offer scanning, backward and forward selection searching, and 16-bit digital-to-analog conversion. Both have 30-track memory and hold six discs. The CDB486 has an 11-button remote controller; the CDB596 has a 21-button remote. $299.99 and $369.99, respectively. Sold under the Magnavox brand. Philips Consumer Electronics Corp., Box 14810, Knoxville, TN 37914. (615) 521-4316. *Circle 63.*

Eagle Eye blind-spot detector. This monitor gives both visual and audio warning of objects in a driver's blind spot. Works in all types of vehicles; does not require an extra cable between tractor and trailer. $269. Chase Manufacturing Inc., 102 W. Main, Oakland, IL 61943. (800) 848-3344; in Ill., (800) 356-9564. *Circle 64.*

Ferrari Formula 1 driving game. This Commodore Amiga program simulates driving a Ferrari F1/86. Users can race on 16 international courses, including Monaco and Detroit. $49.95. Electronic Arts, 1820 Gateway Dr., San Mateo, CA 94404. (800) 254-4525. *Circle 65.*

Mini-Vac miniature vacuum. Removes dust and debris from hard-to-reach places such as computer keyboards and cameras. Measures 5×1¼×1¼ inches. $21.95. Pine Cone, Box 1378, Gilroy, CA 95021. (408) 842-7597. *Circle 66.*

Model 55 weatherproof speakers. These speakers have rubber gaskets to seal out moisture. Each handles as much as 80 watts and offers four-ohm impedance. Dimensions are about 7×9×5 inches. $250 per pair; optional brackets cost $35.95. Altec Lansing Consumer Products, Milford, PA 18337. (800) 258-3288. *Circle 67.*

RJ85 Series projection TVs. Eight models that offer black matrix screens and a 160° horizontal viewing angle. Three 7-inch liquid-cooled tubes reduce screen-dot size by 30 percent. Screens measure 41, 46, or 52 inches. $2,299 to $3,699. Optional eight-inch surround-sound speakers cost $199. Sold under the Magnavox brand. Philips Consumer Electronics Corp., Box 14810, Knoxville, TN 37914. (615) 521-4316. *Circle 68.*

VR97 Series VCRs. Two Super-VHS videocassette recorders let viewers watch two programs at once. Model VR9780AT offers stereo sound and bar-code programming, and can display 4, 9 or 16 channels on the screen. Model VR9770AT provides a 90-decibel dynamic range and a one-month, eight-event calendar. $999.95 and $1,399.95, respectively. Sold under the Magnavox brand. Philips Consumer Electronics Corp., Box 14810, Knoxville, TN 37914. (615) 521-4316. *Circle 69.*

MARKETWATCH

NEW COMPANIES

COMPANY	BUSINESS OBJECTIVE	FINANCING	OFFICERS	OFFICERS' PREVIOUS POSTS
Advanced Superconductors 1875 Thomaston Ave. Waterbury, CT 06704 (203) 753-5215	To manufacture superconducting wire and materials.	Wholly owned subsidiary of Intermagnetics General	Bruce Zeitlin, v.p.	Intermagnetics General, v.p. materials (current)
BioSurge 919 Westfall Rd. Rochester, NY 14618 (716) 271-1430	To develop, manufacture, and market disposable medical devices.	$1.05 million in first round; $300,000 from strategic partner	Jeffrey Bracker, CEO, founder Daniel Wellington, v.p.	Independent consultant Cobe Laboratories, sr. project engineer
Epoch Storage International Box 7849 Riverside, CA 92513 (714) 780-5708	To develop, manufacture, and market an interchangeable optical-storage interface for mainframe computers.	$150,000 in private funds	Michael P. Johnson, president	Tecex Corp., Optical Storage Systems Div., v.p.
General Dynamics Commercial Launch Services, Box 85990 San Diego, CA 92138 (619) 547-8777	To provide marketing, business development, mission analysis, and management services for launching U.S. and foreign satellites.	Wholly owned subsidiary of General Dynamics	Dennis Dunbar, v.p. and managing director	General Dynamics, Space Systems Div., director of commercial-launch services
NTT Wavecom State Road Hill Meadville, PA 16335 (814) 724-6440	To design, manufacture, and market subminiature radio-frequency connectors.	Undisclosed private funds	Sigmund Silberstein, v.p. and general manager	Sealectro, v.p. international sales
Orbital Transport Services 1 East Camelback Phoenix, AZ 85012 (602) 256-6356	To design and build a low-cost, electro-magnetic system for launching commercial payloads into space.	$70,000 from founders	Bruce Rath, president, founder Paul Rath, chairman, founder	Independent electrical contractor AT&T/Mountain Bell, network supervisor
Pamet Systems 989 Main St. Acton, MA 01720 (508) 263-2060	To write DEC VAX software to run an computer data-sharing systems for police and fire departments in cities with less than 100,000 people.	$3 million in private funds	Joel B. Searcy, president	Compudyne Inc., president
ParcPlace Systems 2400 Geng Rd. Palo Alto, CA 94303 (415) 859-1000	To supply an object-oriented programming language and database-design software.	Undisclosed funds from Xerox and venture-capital firms	Adele Goldberg, president, CEO	Xerox Palo Alto Research Center, Systems Concept Lab, manager
Power Integrations 2300 Owen St. Santa Clara, CA 95054 (408) 748-0417	To design, manufacture, and market smart-power integrated circuits.	Venture funds from Kleiner Perkins, Concord Partners	Art Fury, v.p. sales & marketing	Silicanix, v.p. sales & marketing
Reflection Technology 171 Third St. Cambridge, MA 02141 (617) 547-2422	To develop and market a display technology used to build ultra-miniature displays.	Undisclosed funds in first round	Allen Becker, president Michael Feldstein, v.p. engineering	Cadmus Computer, v.p. hardware engineering North Atlantic Industries, division v.p.
Wang Microsystems 1 Industrial Ave. Lowell, MA 01851 (508) 459-5000	To develop, manufacture, and market Wang Laboratories' microcomputer products.	Wholly owned subsidiary of Wang Laboratories	H.P. Ana, general manager	Wang Laboratories, senior v.p. marketing

CONTRACTS AWARDED

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Aerojet TechSystems Box 13618 Sacramento, CA 95853 (916) 355-1000	Martin Marietta	$43 million	To produce four liquid-fuel rocket engines for Commercial Titan launch vehicles.
Aerojet TechSystems Box 13618 Sacramento, CA 95853 (916) 355-1000	U.S. Army Strategic Defense Command	$3.66 million	To continue developing technology that could double the speed of tactical missiles.
Battelle 505 King Ave. Columbus, OH 43201 (614) 424-7984	Electric Power Research Institute	$260,000	To develop technology to assess the risk of failure in seam-welded steam pipes used in fossil-fuel power plants.
BBN Communications 150 Cambridgepark Dr. Cambridge, MA 02140 (617) 873-4000	Japan Air Lines	$26 million	To build and support a worldwide data-communications network through 1990.
Boeing Aerospace Box 3999, M.S. 85-19 Seattle, WA 98124 (206) 773-2816	U.S. Air Force	$1.3 million	To build a system that detects and removes dirt on space-borne optical telescopes.
Chemfix Technologies 2424 Edenborn Ave. Metairie, LA 70001 (504) 831-3600	Formosa Plastics	$1.3 million	To treat nonhazardous industrial wastes at Formosa's plant in Baton Rouge, Louisiana.
Cantel ASC 7916 West Park Dr. McLean, VA 22102 (703) 790-2000	National Oceanic and Atmospheric Administration (NOAA)	$12 million	To modernize the NOAA's public weather-information service with a unified satellite system.
Context 8285 S.W. Nimbus Ave. Beaverton, OR 97005 (503) 646-2600	Northwest Airlines	$1.5 million	To supply documentation-management systems to Northwest's Technical Standards Department, which will use them to develop aircraft maintenance manuals.
Digital Microwave 170 Rose Orchard Way San Jose, CA 95134 (408) 943-0777	Mercury Communications	$11 million	To supply microwave and optical fiber equipment.
Electrospace Systems Box 831359 Richardson, TX 75083 (214) 470-2000	Boeing Aerospace	$2.8 million	To produce communications-antenna systems for the E-6A Tacamo aircraft.
Gould Box 409148 Fort Lauderdale, FL 33340 (305) 797-5756	British Royal Navy	$15 million	To supply 60 ship-based minicomputers for noncombat computing.
GTE Government Systems 77 A Street Needham, MA 02194 (617) 449-2000	U.S. Air Force Armament Division	$7.3 million	To supply the Strategic Air Command with hardware and software to train bomber crews in low-level attacks against layered defenses.
Harris 1025 West NASA Blvd. Melbourne, FL 32919 (407) 727-9100	Provincial Government of Ontario	$14.7 million	To supply the Ontario Provincial Police with microwave equipment for a mobile radio network.

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Harris Govt. Systems Box 37 Melbourne, FL 32902 (800) 442-7747	U.S. Air Force	$41.4 million	To build o test-operations control center for the Air Force Systems Command's Eostern Space ond Missile Center at Cope Canaveral.
Interand 3200 W. Peterson Ave. Chicago, IL 60659 (312) 478-1700	NASA	$1.1 million	To provide an imoge-communicotions system linking NASA's Washington headquarters with Jet Propulsion Loborotory stations in Califarnio, Spain, and Australio.
Litton Industriat Automation 5663 E. Nine Mile Rd. Worren, MI 48091 (313) 497-6000	General Motors Canado	$36 million	To design and build engine components such os cam-carrier and cylinder-head systems.
Ogden Enviranmental Services 10955 John Jay Hopkins Dr. San Diego, CA 92121 (619) 455-2383	ARCO Alasko	$14 million	To clean up PC8-contominated soil at ARCO's Swonsan River Field on the Kenai Peninsula in Alasko.
Racal-Milga 8ox 407044 Fort Lauderdale, FL 33340 (305) 475-1601	Science Applicatians International	$40 million	To provide multiplexers and modems for the U.S. Defense Department's Comprehensive Health Core System project.
Sanders Associates Daniel Webster Highway S. Nashuo, NH 03061 (603) 885-2816	U.S. Navy	$1.3 million	To design, develop, and build calor cockpit displays far carrier-based oircroft.
Spire Patriots Pork 8edford, MA 01730 (617) 275-6000	NASA	$485,000	To develop low-cost AlGoAs laser arrays for solid-state loser pumps.
Spire Patriots Pork 8edford, MA 01730 (617) 275-6000	U.S. Army Laboratory Command	$5 million	To develop an X-ray lithogrophy simulator for the semiconductor industry.
Tigon 17085 Knoll Trail Dr. Dollas, TX 75248 (214) 733-2700	Ford Motor Compony	$4.5 million	To supply voice-messaging services to Ford's locotions notionwide.
Trocar 6500 Trocor Lone Austin, TX 78725 (516) 929-2271	U.S. Army Armoment, Munitions, and Chemicol Commond	$4.4 million	To continue production of M76 infrared smoke grenodes, which mask the M1 tonk and other vehicles from weapons using infrared imaging systems.
Tracor Marine 6500 Tracor Lane Austin, TX 78725 (516) 929-2271	U.S. Novy	$8.7 million	To operate ond maintain the Novy's Ocean Construction Equipment Inventory.
TRW 2111 Rosecrons Ave. El Segundo, CA 90245 (213) 535-3184	Peaple's Republic of Chino	$3 million	To provide hardware for an entrained coal-combustion system, which burns coal with o minimum of pollution.
Unisys Box 500 8lue 8ell, PA 19424 (215) 542-2243	Air France	$15 million	To supply two 1100 Series mainfrome camputers, along with upgrades ond extensions far mass-storoge systems.
Versacod 2124 Main St. Huntington Beach, CA 92648 (714) 960-7720	Califarnio Transportation Department	Not disclosed	To provide computer-oided design saftwore and training for the stote's engineering projects.

MERGERS

COMPANY	BUSINESS	COMPANY	BUSINESS	NEW NAME
DNA Plant Technology 2611 Bronch Pike Cinnaminsan, NJ 08077 (609) 829-0110	Develops new plant varieties using tissue-culture technology	Advanced Genetic Sciences 6701 San Pablo Ave. Oakland, CA 94608 (415) 547-2395	Develops products to protect crops from frost	Undetermined
Intercim 12217 Micollet Ave. South Burnsville, MN 55337 (612) 894-9010	Manufactures integroted automotion systems	Daedal Systems 9951 Valley View Rd. Minneapolis, MN 55344 (612) 944-0072	Produces networked statistical-process-control software	Intercim

ACQUISITIONS

BUYER	BUSINESS	COMPANY ACQUIRED	BUSINESS	AMOUNT
Datum 1363 S. State College Blvd. Anaheim, CA 92806 (714) 533-6333	Makes time- and frequency-measurement products	Austron Box 14766 Austin, TX 78761 (512) 251-2341	Makes time- and frequency-monagement products	$11.7 million
SmithKline Beckman 1 Franklin Plaza Philadelphia, PA 19101 (215) 751-4000	Markets health-care products for people and animals	International Clinical Laboratories 5 Park Plaza Nashville, TN 37202 (615) 327-1025	Provides general medical-test services; researches infectious diseases	$400 million
Teradyne 321 Harrison Ave. Boston, MA 02118 (617) 482-2700	Manufactures automatic test equipment and software	Attain 720 S. Milpitas Blvd. Milpitas, CA 95053 (408) 945-1393	Supplies analog and mixed-signal automatic test equipment	Not disclosed
Tracor 6500 Tracor Lane Austin, TX 78725 (512) 926-2800	Makes defense electronics and analytical equipment	Elsin 3080 Oakmead Village Dr. Santa Clara, CA 95051 (408) 748-9900	Develops surveillance equipment and military digital-signal processors	Not disclosed
Tracor 6500 Tracor Lane Austin, TX 78725 (512) 926-2800	Manufactures defense electronics and analytical equipment	General Image Engineering 1652 West 820 North Provo, UT 84601 (801) 377-9090	Makes coating materials to protect military equipment	Not disclosed
Valid Logic Systems 2820 Orchard Parkway San Jose, CA 95134 (408) 945-9400	Makes computer-aided design, manufacturing, and engineering systems	Calma's IC CAD business 501 Sycamore St. Milpitas, CA 95035 (408) 434-4000	Builds integrated-circuit (IC) computer-aided design (CAD) systems	$3 million (est.)
Western Digital 2445 McCabe Way Irvine, CA 92714 (714) 863-0102	Makes semiconductors, electronic assemblies, and data-storage subsystems	Vericom 545 Weddell Dr. Sunnyvale, CA 94089 (408) 747-1222	Produces graphics boards and monitors for computer-aided design systems	$12 million
Xerox Box 1600 Stamford, CT 06904 (203) 329-8700	Supplies electronic equipment, copiers, and computers	Datacopy 1215 Terra Bella Ave. Mountain View, CA 94043 (415) 956-7900	Makes desktop scanners and image-processing systems	$31 million
Xyvision 101 Edgewater Dr. Wakefield, MA 01880 (617) 245-4100	Produces professional publishing systems	Contex Graphics Systems 43 Manning Rd. Billerica, MA 01821 (508) 663-3200	Develops color design and production systems	Not disclosed
Zycad 3500 Zycad Rd. Saint Paul, MN 55112 (612) 779-5555	Builds computers for computer-aided design and engineering	Endat 11001 Cedar Ave. Cleveland, OH 44106 (216) 229-8900	Supplies computer-aided design software	Not disclosed

JOINT VENTURES

COMPANY	COMPANY	PURPOSE	CONTACT
Agouron Pharmaceuticals	Eli Lilly	To develop new therapeutic drugs.	Agouron Pharmaceuticals 11025 N. Torrey Pines Rd. La Jolla, CA 92037 (619) 535-5500
Beehive International	Alcatel Information Systems	To give Alcatel manufacturing rights to Beehive's IBM-compatible display terminals.	Beehive International 4910 Amelia Earhart Dr. Salt Lake City, UT 84116 (801) 355-6000
Base	Honda	To design a music system for the U.S.-built Honda Accord Coupe.	Base The Mountain Framingham, MA 01701 (508) 879-7330
Contel ASC	Telenet Communications	To jointly pursue a contract to provide a telecommunications network for the U.S. Department of State.	Contel ASC 7916 West Park Dr. McLean, VA 22102 (703) 790-2000
Digital Equipment	Micratel Ltd.	To develop a management system for public-exchange telephone networks such as those run by regional Bell operating companies and independent phone companies.	Digital Equipment 397 Williams St. Marlborough, MA 01752 (508) 490-0445
DNA Plant Technology	Continental Grain's CentiSeed Division	To develop plants that produce edible, nutritional oils.	DNA Plant Technology 2611 Branch Pike Cinnaminson, NJ 08077 (609) 829-0110
Ecogen	EniChem	To develop plants containing genes that produce proteins to repel destructive caterpillars and beetles.	Ecogen 2005 Cabot Blvd. West Langhorne, PA 19047 (215) 757-1590
EG&G	Eagle Industry	To form the Japanese company Eagle EG&G Aerospace, which will distribute each company's products in Southeast Asia's aircraft and aerospace markets.	EG&G 45 William St. Wellesley, MA 02181 (617) 237-5100
IBM	Supercomputer Systems	To develop parallel-processing supercomputers.	IBM 900 King St. Rye Brook, NY 10573 (914) 934-4855
IXYS	ASEA Brown Boveri	To develop products for the industrial power-control market.	IXYS 2355 Zanker Rd. San Jose, CA 95131 (408) 435-1900
Northern Telecom	China Tong Guang Electronics	To manufacture and distribute Northern Telecom's Meridian SL-1 integrated services network and digital telephone sets in the People's Republic of China.	Northern Telecom 200 Athens Way Nashville, TN 37228 (615) 734-4576
Optical Storage Solutions	Optical Media International	To establish a standard file format and data premastering process for write-once, read-many (WORM) and erasable optical disks.	Optical Storage Solutions 1130 D Burnett Ave. Concord, CA 94520 (415) 825-3441
Syngene Technologies	Lubrizol	To form Synagra Research, which will commercialize new plant products developed using biotechnology techniques.	Syngene Technologies 2050 Concourse Dr. San Jose, CA 95131 (408) 433-9800

RESEARCH REPORTS

STUDY BY	TITLE	FORECAST	PRICE
Business Communications 25 Van Zant St. Norwalk, CT 06855 (203) 853-4266	LAN Media: How Much? What Kind? When? (#G-111)	The market for coaxial, twisted-pair, and fiber-optic cable for local-area networks will grow 22 percent annually, reaching $427 million by 1992.	$2,250
Find/SVP 625 Ave. of the Americas New York, NY 10011 (212) 645-4500	High Technology Industrial Ceramics	The U.S. market for advanced ceramic materials will increase from $2.1 billion in 1986 to $12.5 billion by 2005.	$1,450
Freedonia Group 2940 Noble Rd. Cleveland, OH 44121 (216) 381-6100	Electronic Banking (#836)	Sales of electronic-banking equipment will reach $600 million by 1992, growing 7 percent annually. Point-of-sale debit terminals represent the largest growth segment.	$800
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	Multi-User Microcomputer Systems (#A1770)	Threatening the minicomputer market, the multi-user microcomputer market will grow to $8.2 billion by 1992, up from $3.7 billion in 1987.	$1,975
Input 1280 Villa St. Mountain View, CA 94041 (415) 961-3300	Annual Information Systems Planning Report	The major issues in managing information systems include connectivity, integration, and user involvement. The report discusses each issue in terms of industry trends.	$2,400
International Data 5 Speen St. Framingham, MA 01701 (508) 872-8200	The U.S. Desktop Page-Scanner Market: Review and Forecast 1986-1991 (#3281)	Current advances in technology, price/performance, software, and user acceptance will cause 110 percent growth in office-scanner shipments.	$995
Kalba International 23 Sandy Pond Rd. Lincoln, MA 01773 (617) 259-9589	Opportunities in Japanese Telecommunications Services	This rapidly changing market presents many business opportunities for service ventures and product sales. Reviews key markets and the strategies of major suppliers.	$25,000
Market Intelligence Research 2525 Charleston St. Mountain View, CA 94043 (415) 961-9000	Electromagnetic Interference Shielding Equipment and Facilities Markets (#A163)	Sales of shielded equipment and facilities will reach $8 billion by 1993, driven by strong military, government, and industry demand.	$995
Market Intelligence Research 2525 Charleston St. Mountain View, CA 94043 (415) 961-9000	Audiology Device Markets (#A199)	The market for diagnostic, rehabilitative, and surgical devices will reach $566 million in 1989 and surpass $780 million by 1993.	$995
Newton-Evans Research 3220 Corporate Court Ellicott City, MD 21043 (301) 465-7316	Interconnectivity: The Role of TCP/IP	The market for Transmission Control Protocol/Internet Protocol (TCP/IP) technology, which allows unlike systems and networks to communicate, will reach $3 billion by 1992.	$995
Ovum 601 Ewing St. Princeton, NJ 08540 (609) 921-6886	Computer-Aided Software Engineering: Commercial Strategies	The U.S. market for computer-aided software engineering (CASE) products will grow to $1.6 billion by 1992.	$595
Technical Insights 32 North Dean St. Englewood, NJ 07631 (201) 568-4744	Neuracomputing: The Technology, The Players, The Potential	The market for computers that emulate the workings of the human brain will increase from $7 million in 1987 to $570 million by the year 2000.	$1,350
Wheeler Associates 120 N. Mulberry St. Elizabethtown, KY 42701 (502) 765-6773	Permanent Magnets—1988 Update	Production of rare-earth iron magnets will expand from $70 million in 1987 to $1.7 billion in 1997.	$2,450

GET THE EDGE

In case you missed any of these stories when they appeared in HIGH TECHNOLOGY BUSINESS, here is a selected listing from the past year. Check the stories you want and fill in the form. Include $5 for each story to cover photo-copying, postage, and handling.

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- ☐ Cheyenne Software
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- ☐ Mentar Graphics
- ☐ NCR
- ☐ On Technology
- ☐ Presidentiol Adviser William Graham
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COMPANY INDEX

The following is a list of companies mentioned in this issue and the pages on which they appear. Companies in Marketwatch, the High Technology Business Leading 100, and Newsletter Digest are not included.

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Place your ad in this space . . . and reach nearly 170,000 upscale, corporate decision-makers for one full month.

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To reach corporate decision-makers who ACTIVELY pursue business information in all areas of high technology, there is NO OTHER place to go but *High Technology Business* magazine. Inquiries about the ads in *High Technology Business* magazine skyrocketed 160 percent from September to October 1987.

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Name _____

Company _____

Address _____ City _____

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Robot Caddy, Diet Software

LEISURE

This caddy is ever faithful

EMBARRASSED by a smirking caddy when you neglect to add penalty strokes for the fairway shot that ended up in the lake? Maybe you should take on an electronic caddy—the Shedda, manufactured by Gettig Technologies. This three-wheeled, battery-powered cart faithfully follows a small radio transmitter strapped to a golfer's back. Each unit responds to its own frequency, so there's little chance of the Shedda wandering off after another member of a foursome.

The cart has two one-half-horsepower motors designed to match various walking paces and is programmed to stay at least four feet away from the golfer. The Shedda's wide wheelbase and low center of gravity lend it stability, and a position-sensing system provides extra balance on hillsides. When its battery is fully charged, the cart will work through about 27 holes of golf.

But good caddies don't come cheap; the Shedda costs $2,350. Extra-cost options include a sporty body shell, an extra bag rack, fenders, a sweater basket, and drink holders.

Gettig Technologies is located at 1 Streamside Pl. East, Spring Mills, PA 16875. For more information, call (814) 422-8892.

—Kenan Woods

Nutrition programs: great data, less filling.

STEVEN MARK NEEDHAM

TRAVEL

Computer translates for travelers

WHETHER FOR business or pleasure, travel requires communication. The Voice, a hand-held computer from Advanced Products & Technologies, translates spoken English into French, Spanish, German, or Italian.

The machine is a portable voice processor. During a 1½-hour training session, it learns to recognize the tone and pattern of its owner's voice. After that, the traveler simply speaks into the computer. The Voice displays what it hears on a 16-line liquid-crystal display. If the display is correct, you hit a *talk* button. The device then produces a translation, either on its screen or through a speaker.

Four interchangeable cartridges, one for each language, each hold more than 10,000 five-word phrases. Two cartridges, a rechargeable battery pack, and a carrying case are included for $1,500.

The device cannot translate a native's reply, but a traveler could go far asking questions that require only a yes or a no, says Greg Ness, manager of marketing at Advanced Products. The company's address is 15444 N.E. 95th St., Redmond, WA 98052. Telephone (206) 883-8297.

—Jennifer Christensen

There's no reason to tip these electronic caddies, and they won't snicker.

DIET

Software puts the bite on calories

PEOPLE CAUGHT up in the great American health craze may find the Nutrition Expert I software just the thing for keeping track of their diet.

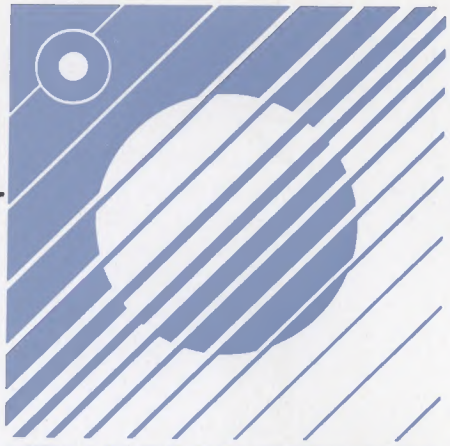
A database of 400 foods—compiled from 13 nutritional-information sources—powers three programs. The first, called Needs, computes a person's nutritional requirements based on factors such as age, height, and weight. A second program, Diet, analyzes a person's diet for vitamin and iron requirements. The Check program evaluates the nutritional value of various foods.

Dieters can customize the database by adding foods, and also update the nutrient value. In addition, the software can be tailored for people with special needs, including those with high blood pressure, and pregnant or nursing women. The software can also keep track of a person's intake of fats, sodium, calcium, protein, and cholesterol.

The $60 package was developed by Nutri-Ease and is published by Paperback Software International. It runs on IBM and compatible personal computers with at least 384 kilobytes of random-access memory.

Contact Nutri-Ease, Box 16458, Encino, CA 91416. Telephone (818) 994-9097.

—Elizabeth Aaron



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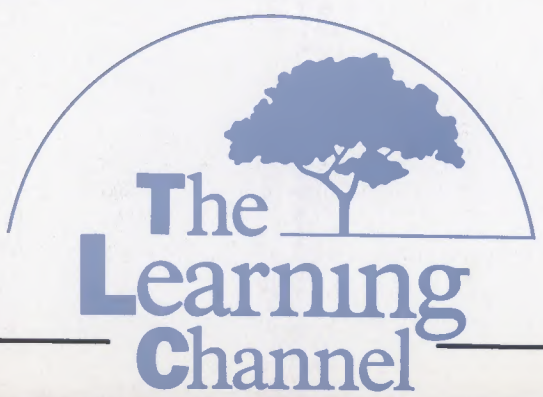

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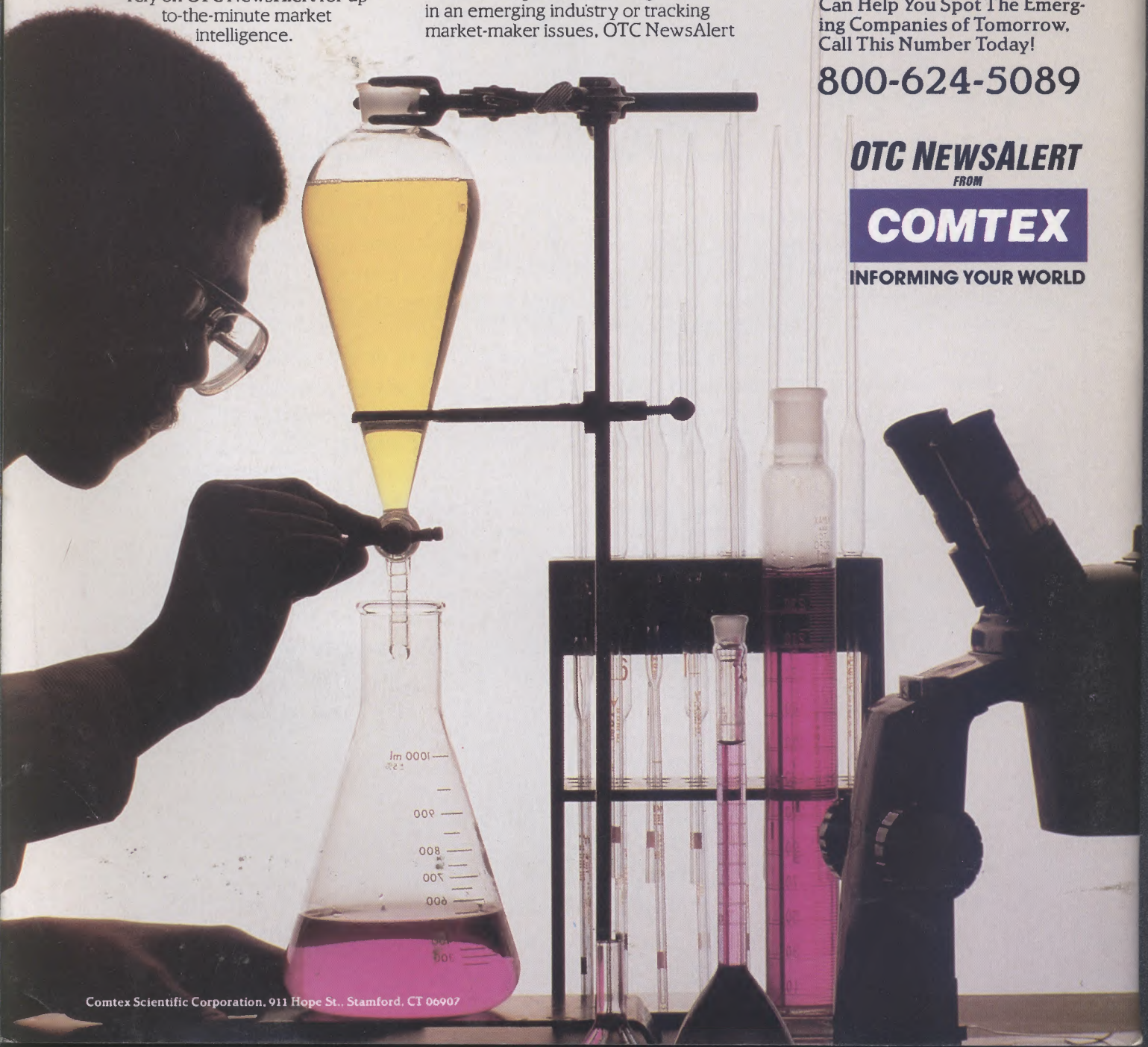

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